Learning about biodiversity:

Investigating children's learning at a museum, environment centre and a live animal show

Tagxedo image to show Year 4 post-visit pupil responses to the question 'Is there a natural place or outdoor space you like?'. Words are shown with size proportional to their frequency of occurrence

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Dedication

In memory of Joseph Strachan, Charles Sim and Margaret Sim.

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Abstract

School trips in environment centres, in museums and at live animal shows can cover the same curriculum objectives, relating to habitats and adaptations, at age-appropriate levels. However, each of these three settings has traditions and goals which influence the subtexts conveyed by educators, and therefore the messages pupils gather from learning experiences. This research investigated children's experiences in these three different informal learning settings in London, UK. The aim was to identify and understand the learning that took place.

The main evidence was collected with 180 year 4 pupil participants from local state primary schools. Their learning is visualised in a conceptual framework 'SPEAK' that represents learning in the domains of Skills, Place, Emotion, Attitudes and Knowledge (SPEAK). Analysis was based on an existing socioecological literacy framework.

There is evidence that the environment exploration was the source of considerable motivation for children. Live animal shows led to children describing species, and subsequently recalling aspects of individual animals' personalities. Natural history specimen collections developed skills of observation, identification, discovery and reading.

A representation of the SPEAK domains is proposed as a tool for reflection for educators, to review the learning intentions of informal teaching experiences. A case study at the Royal Veterinary College shows how it has been used to understand learning, using iPads. A salience theory of informal learning is proposed through considering memorable and transformative aspects of informal learning, from a learning psychology perspective. Aspects of this theory are suggested as areas for future research.

Chapter 1 Introduction

1.1 Range and scope

What do children learn about biodiversity in informal learning settings?

Research to understand the thesis question above was undertaken in England in 2012, focussing on the use of biodiversity informal learning settings by primary school classes. The use of informal science experiences by schools has become an increasingly important field of research (Price and Hein, 1991; Braund and Reiss, 2004; Bell, 2009). Biodiversity education is considered to be important; for example, in 2012 an Earth Summit was held in Rio de Janeiro, and the role of biodiversity education in habitat preservation was addressed. Earth Summit attendees from around the world concluded that biodiversity education was an important priority. Natural history collections in museums are one example of an informal biodiversity setting; in this research the term 'informal biodiversity setting' includes places which offer public engagement activities about the natural world, such as zoos, gardens and environment centres. This broad definition is similar to that used in a National Science Foundation funded forum '21st Learning in Natural History settings' (Smithsonian National Museum of Natural History, Washington, Oct 2011 and Jan 2012). The three informal biodiversity learning settings that are presented in this thesis are an environment exploration, live animal show and a museum animal specimen collection.

After justifying the choice of research question in this chapter, a literature review (Chapter 2) will present existing research about children's learning about biodiversity in environment, zoo and museum activities. This will be related to children's learning about biodiversity in school. Anecdotally, there are differences in children's learning in different biodiversity settings; therefore, the active hypothesis is that there should be a difference in learning between classes that have access to different settings.

However, the nature of the specific differences in learning that might arise is currently a gap in the literature.

A pilot study aimed to explore children's learning in different biodiversity settings by asking the question 'Is there a benefit to primary children on a school trip when indoor (specimen handling) and outdoor learning (environment exploration) are linked?'. Chapter 3 describes this pilot study, based at the Natural History Museum in London, and presents results that suggest there is a complementary relationship between indoor and outdoor biodiversity learning; the former developing identification skills and the latter increasing motivation. Chapter 4 describes the methods used to address the thesis question. The thesis as a whole characterises learning in different biodiversity settings, with the null hypothesis that learning about biodiversity by primary pupils does not significantly differ in each of three settings: specimen handling, environment exploration and live animal shows. This thesis demonstrates that there is a difference in what children learn in different informal biodiversity settings, despite all three addressing year four English curriculum learning objectives relating to habitats and adaptation. These differences in learning are presented in Chapter 5 and summarised in the domains of Skills, Place, Emotion, Attitudes, and Knowledge. These are not intended to be a rigid framework to guide biodiversity education; rather, they provide a conceptualisation of children's learning that was observed in the three settings, which can be used by educators as a prompt for reflection on learning goals. Chapter 6 addresses the issue of memorable and transformative learning experiences, drawing together the thesis' results and literature from the fields of neuropsychology, place-based education and non-educational fields to propose a theory of salience in informal learning. This extends the question from 'What do children learn about biodiversity?' to include consideration of how this learning takes place.

The following Section will outline how the views of informal biodiversity education providers in a range of UK settings have been taken into account when choosing this research focus, in addition to personal experience.

1.2 Question Justification: Consultation for a research question

The International Year of Biodiversity (IYB) in 2010 was a catalyst for themed education activities for school groups in many types of organisations, including environment centres, zoos and natural history museums. The main aim of the IYB was to raise the public profile of the importance of biodiversity, and international events were co-ordinated by the Convention for Biological Diversity (CBD), which is funded by the United Nations (UN). The legacy of IYB is the decade of biodiversity, 2011-2020.

At the time of the IYB, I had been working at the NHM for two years. I had been involved in education activities around the theme of biodiversity, and I had met a range of stakeholders in the field of biodiversity education. Evaluation of the UK events for the IYB focussed on marketing and communications impacts, and showed that there had been a positive impact on public awareness of the term 'biodiversity' and the implications of biodiversity loss (Echo Ltd, Jan 2011). I identified that there was potential to gather evidence about the range and scope of education programmes. In 1994, Braus and Champeau had carried out a large scale survey of US biodiversity education professionals for the World Wildlife Fund, focussing on biodiversity education provision. They found that there was support for partnership between formal and experiential learning about the natural world; however, there was a paucity of education resources for teachers.

I had heard many anecdotes about innovative education activities for IYB during 2010, and I wanted to gather information more systematically in order to present a snapshot of current themes in education about the natural world. My aim was to identify a focus for research that would be useful practically as well as addressing a gap in the research literature. I circulated a questionnaire by email and as an online survey, asking for both quantitative information, for example about the number of visitors, and qualitative comments, such as educators' recommendations for how to improve informal education about the natural world. Forty organisations responded, the majority being based in the United Kingdom (Figure 1.1).

Figure 1.1 Location of respondents to an online questionnaire about International Year of Biodiversity Education activities. The study was undertaken by the author in preparation for choosing the research question (Sim, 2011)

I summarised the findings in a practical report for participants (Sim, 2011), and used the information, together with insight from the literature review in Chapter 2, to identify the thesis' question: *What do children learn about biodiversity in informal learning settings?*

The rationale for the question lies in two key ideas: firstly, that biodiversity learning experiences can take a wide variety of formats, as shown in Figure 1.2. Having worked in a variety of informal biodiversity settings (e.g. zoo, environment centre, boat, museum), I had seen first-hand how children respond to teaching and activities in these different settings. However, I wished to gather more substantive evidence to examine critically the learning that takes place in different settings.

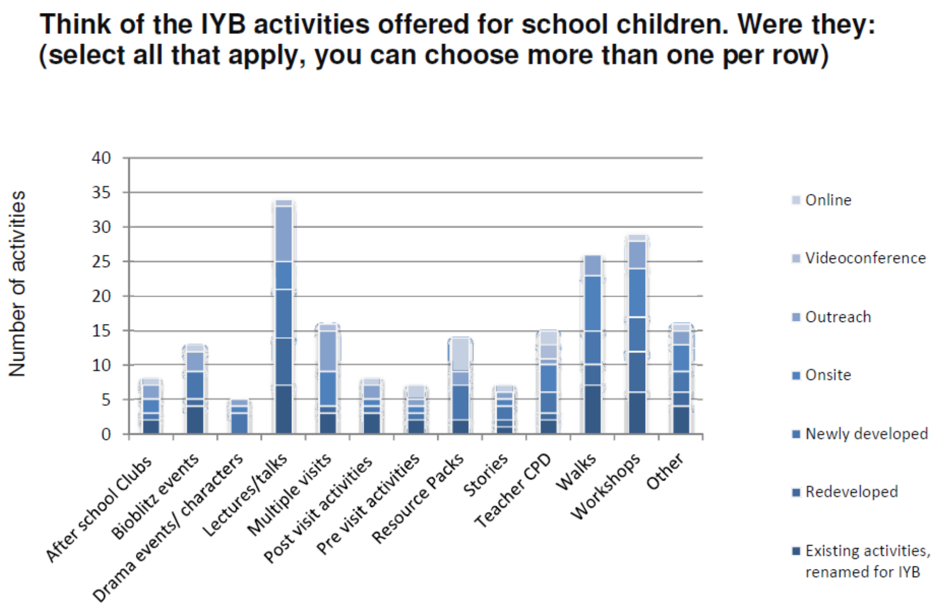


Figure 1.2 Respondents to an online questionnaire (shown in Figure 1.1) categorised the type of learning activities they offered about biodiversity in the International Year of Biodiversity (IYB) in 2010. Source: Sim (2011)

Secondly, when asked for recommendations about how to improve informal biodiversity education, educators recommended that children be given access to authentic learning experiences:

> The use of more props during school talks and encounters would be a great benefit, encouraging more interactivity with children and the topic of biodiversity
>
> Let them experience biodiversity first hand. Get them out into the countryside
>
> (Sim, 2011:16)

However, the assumed definitions of 'authentic' varied; they included three aspects: 1) real, three-dimensional specimens, 2) outdoor learning and 3) live animals. This depended on respondents' contexts, for example whether they worked in indoor or outdoor settings. The pilot study described in Chapter 3 focuses on the first two aspects of authenticity, specimens and outdoor learning, as a precursor to the main thesis question which covers all three aspects.

There was a call from survey respondents for partnership and support between biodiversity education providers in order to offer improved experiences for schools. What benefit would that confer for children? This thesis addresses the question and reveals subtle differences in what children learn in different biodiversity settings.

1.3 Research perspective

1.3.1 Epistemology

Epistemology refers to theories of knowledge, to knowing and learning, at the juncture of psychology and education (Yang and Tsai, 2012). With any research, it is important to state epistemological understanding and perspectives that are informing my interpretation of the literature, and will subsequently be drawn upon in planning the research methodology.

Kelly et al. (2012) classify three overlapping perspectives for epistemology in science education, and their categorisation will be used as a frame of reference. Firstly, the disciplinary perspective draws from history and philosophy of science and focuses on scientific theories and models (Duschl and Grandy, 2008). This can be seen as a modernist perspective, with respect for evidence, rationality and justification to find truth. Secondly, the personal perspective (Yang and Tsai, 2012) is focussed on the learner and examines how theories of knowledge change. Thirdly, the social practice perspective asks what counts as knowledge in local contexts. Social interaction within networks is acknowledged as a legitimate way for knowledge to be dynamically created and affirmed, according to context.

Epistemological perspectives influence research methodologies and interpretation of results. The disciplinary perspective is associated with focussing on the ways in which specific concepts and processes in science are learnt in science. This research looks at the topic of habitats and adaptation at a primary school year four level. If this research had an exclusively scientific disciplinary perspective, the research question would be something like: ‘Which informal science learning method is the most effective for teaching children about habitats and adaptation?’ The sort of responses that would be used to assess effectiveness would be performance in a test of scientific knowledge about habitats and adaptation.

Where epistemological perspectives are personal, research explores what happens to individual learners’ ideas in different situations. Kelly et al. explain that “methodologically, this research tradition focuses on developing instruments to measure learners’ beliefs about knowledge and learning and correlating them to a variety of other student factors” (2012:284).

The social practice perspective would aim to examine the nature of interactions between learners, and how these change what knowledge is, and how such knowledge develops. If this research took an exclusively social practice perspective, then the question would be something like: ‘How are interactions between learners different in a variety of natural history settings?’.

Figure 1.3 shows the initial epistemological position of this research (the black dot). A respect for disciplinary epistemology has been developed through experience as a class teacher, where assessment measures progress towards defined curriculum concepts and skills. It is important to note that this experience as a class teacher means I will not be suggesting a deficit model for formal teaching as inferior to informal education; instead I am researching the unique opportunities afforded by informal education.

The pilot study research question is framed in terms of benefits to the learner; it takes a personal perspective and compares what learners know before and after two different types of informal science education about habitats and adaptation. Experience observing children’s actions in formal and informal learning settings, formal teacher training and museum studies have developed the recognition that social interactions are important factors in informal science learning. Therefore, the initial epistemological perspective of this research is as shown. The next Section will relate epistemological grounding to learning about biodiversity.

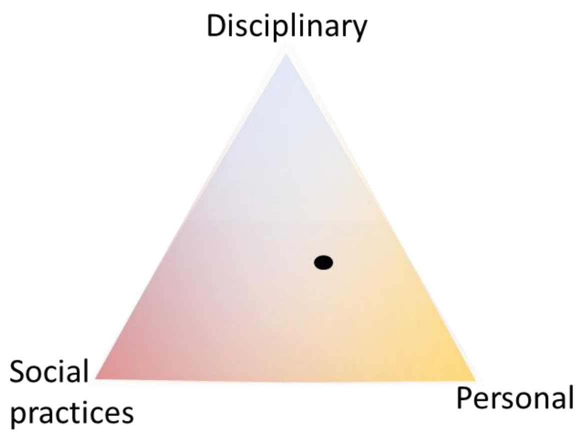


Figure 1.3 Illustration to explain the three epistemological perspectives outlined by Kelly et al. (2012); the black dot shows the initial epistemological perspective of this thesis

1.4 What is biodiversity?

1.4.1 Definition of Biodiversity Education

There is debate in the literature about the definition of 'biodiversity'. The definition in the Oxford English Dictionary (2011) includes the purpose of maintaining variation:

> The variety of plant and animal life in the world or in a particular habitat, a high level of which is usually considered to be important and desirable.
>
> (Oxford English Dictionary, 2011: 51)

> From a broad scientific perspective, it is generally agreed that biodiversity means genetic variation within and between species, and between ecosystems. Biodiversity research includes scientific research in the fields of biogeography, conservation biology, genetics, ecology, entomology, botany, palaeontology, taxonomy/systematics and zoology
>
> (Reid and Miller, 1989)

This research takes the view that biodiversity education is a field that shares content and goals with environmental education (Sauvé, 2005); perspectives on environmental education will be discussed in Chapter 2. Specifically, biodiversity education is a term that acknowledges the political aspects of nature, and plurality of viewpoints (Van Weelie and Wals, 2002). This is a view in agreement with the former English Council for Environmental Education (CEE) publication *Guidelines for Biodiversity Education* (1997) which defines biodiversity education as 'nature with a hard edge', explaining that this includes tough decisions which acknowledge a range of social, ethical and moral perspectives. Both 'biodiversity' and 'biodiversity education' are ill-defined according to the literature (Dreyfus et al., 1999). Biodiversity education has even been dismissed as a term that is not useful (Slingsby, 2011) for school pupils:

> Biodiversity has become an educationally unhelpful word, and what it originally meant needs to be reclaimed by ecologists and regarded as "biological diversity" or simply "ecology".
>
> (2011:206)

Furthermore, in England the BBC did not use the term 'biodiversity' for their programming during the International Year of Biodiversity, as it was found to be confusing for 40% of the public in front end consultation (personal communication, Defra Education and Public Understanding Biodiversity Special Interest Group, 2010).

Dreyfus et al. (1999) state that the ill-defined nature of the term 'biodiversity' can be a positive aspect for teaching; in their opinion, this accurately reflects socio-scientific dispute around natural resources. They refute arguments that this renders the term useless by recommending that pedagogy allows exploration of pluralism and acknowledges multiple perspectives. Slingsby's (2011) criticism is referring in part to the range of perspectives about biodiversity that may interfere with school pupils confidently progressing in their understanding of key scientific ideas about the environment. It makes sense that young pupils need to identify what natural resources actually are before understanding the politics around sustainable use of natural resources. It is clear that an academic, political definition makes the topic more suited to secondary curricula. Resource books such as *Biodiversity for Educators* (WWF, 2010) and *Biodiversity is Life* (WAZA, 2011) offer practical guidance for teachers of younger children about exploring multiple perspectives.

Van Weelie and Wals' (2002) research investigated perspectives regarding biodiversity education in The Netherlands. A triangulated study of biodiversity education providers showed three perspectives: Nature and the self; Ecological literacy; and the Politics of Nature. The perspective 'Nature and the self' is about developing affinity for the natural world, with a view to acting to help preserve it. The perspective 'Ecological/environmental literacy' (also see Roth, 1992; Orr, 1995; Peacock, 2004) includes human impact on the environment, in addition to the scientific ideas associated with the English curriculum content relating to interdependence and adaptation (species, habitats, ecosystems, relationships between species, food webs, variation, evolution). The 'Politics of Nature' perspective is about understanding that resources are not distributed equally, and how international politics affect aspects such as sustainability, democracy and global relationships. The three perspectives to emerge from this Dutch study can be compared to the overall goals for environmental education in that they relate to personal development, scientific knowledge and the social context of the environment. Van Wheelie proposes them as criteria to assess current biodiversity education provision, with a view to informing curriculum development.

In Section 2.2 I will explain that Sauvé (2005) identifies fifteen currents underlying environmental education, and the position of biodiversity education will be considered using this broader frame of reference.

Why are issues surrounding biodiversity education particularly important for current learning? Biodiversity loss and the need to expend resources in the short term, to protect resources in the long term, still dominate news in biodiversity. A meeting in 2006, 'Conference of the Parties', published additional recommendations, calling upon the United Nations Educational, Scientific and Cultural Organisation (UNESCO), members and organisations to support biodiversity education and to acknowledge the importance of education and public awareness as elements vital to treaty implementation. Additional information on historical developments around biodiversity protection is provided by Palmer (1998) and Silvertown (2010). Education with the goal of protecting biodiversity is still agreed to be an important issue internationally; for example, it was discussed at the United Nations International Conference for Sustainable Development, the 'Earth Summit: Rio +20' in Summer 2012. This event refers back to a previous Earth Summit held in Rio de Janeiro in 1992, which is seen to be landmark in terms of highlighting the importance of conserving biodiversity.

The International Year of Biodiversity was a focus point for media and communications in 2010, and there is evidence to show that the public awareness of biodiversity increased in the UK (Echo Ltd, 2011). However, twenty years after the Earth Summit in Rio de Janeiro in 1992, where biodiversity education first became high profile, there is a perception that negative stories about habitat preservation and species conservation dominate headlines. Critics of biodiversity education and related fields cite loss of wild space as a failure of education about the natural world (Saylan and Blumstein, 2011).

What kind of progress would indicate success for biodiversity education? How should pupil views change? How might this affect the environment, and over what timescale? This research aims to explore the benefits for pupils who take part in different types of informal sessions that develop understanding about biodiversity, in order to understand distinctive learning points from different settings. The next Section looks at the related field of sustainability education.

1.4.2 Sustainability education

Sustainability education takes a more anthropocentric approach to ecology than biodiversity education, with one of the goals being to moderate use of natural resources so that they can be used fairly by current and future generations, given the increasing human population (e.g. Silvertown, 2010). The Sustainable Schools Framework was published in 2006 (Department for Children, Schools and Families, 2006a) and outlined eight 'doorways' through which English schools could promote behaviour that would contribute to long term decreases in use of natural resources; Food and Drink, Travel and Traffic, Buildings and Grounds, Energy and Water, Purchasing and Waste, Inclusion and Participation, Local Wellbeing and the Global Dimension. Sustainability is seen to be a broader concept than biodiversity; in 2010 Defra's Education and Public Understanding Special Interest Group for Biodiversity published 'Top tips for Biodiversity' in partnership with DCSF, as a means to address the issue that there was no ninth 'biodiversity doorway' in the framework.

Pupils need a good understanding of the inter-relationships within and between ecosystems in order to appreciate why personal actions relate to sustainability. According to progression frameworks about the natural world in England (National Curriculum, also see Barker and Slingsby, 1997), pupils need to understand species names, where they live and their mode of nutrition as a pre-requisite to building up conceptualisations of inter-related networks. Therefore, the taxonomic aspect of biodiversity education (naming and classifying) is an important foundation for sustainability education, which has clear links to choices in pupils' future daily lives. Understanding taxonomy, the science of naming and classifying living things, is important both for society (for example, for conservation, Dayton, 2003) and for individual wellbeing through understanding and appreciating species richness (Dallimer et al., 2012). The Natural Environment Research Council in the UK conducted a review of Taxonomy and Systematics in the UK in 2012, following three House of Lords inquiries. Stakeholders, including the Royal Botanic Gardens in Kew, the Linnaean Society and the Natural History Museum, were consulted, and the review concluded that organisations which rely upon and extend understanding of taxonomy need to involve younger generations in understanding this important area of science (NERC, 2012).

This Section has explored understandings of biodiversity education and the related concept of sustainability education. It has shown that the multiplicity of factors involved in choices that affect world and local biodiversity are critical concepts in biodiversity education.

1.5 Personal context

This research is based at the Institute of Education, London and is independently funded. The question focus is in the field of social science research but is intended to be relevant to scientists who are involved in communicating research about biodiversity. Personal experience in science communication is the lens through which I am viewing both the literature and study design and results; therefore, it is relevant to explain my own background experiences at this stage.

My initial introduction to science communication was half way through a Natural Sciences Zoology degree, and I was working on mountain paths in the Picos de Europa Mountains in Spain as part of a John Muir project during the holidays. I was more than surprised to gather an audience when I explained the communication purpose of bee dances, when we found a hive whilst working. When I returned, I volunteered for the Cambridge Science Festival and student ambassador programme ‘Stimulus’, to expand my experience of science communication. I regularly visited a local school and was given a group of enthusiastic year 4 scientists who wanted to try out experiments. Several owl pellets and paper planes later I realised that a PGCE was the next logical step, so I became a class teacher. I met inspirational mentors along the way, particularly Kiwi Katrina Bull who introduced me to the New Zealand curriculum Te Whariki. I completed a PGCE part time whilst volunteering at London Zoo in the Education Department. This meant I was able to develop the skills of working with live animals (corn snakes, cockroaches and giraffes) at the same time as getting used to the structure and requirements of formal education. I also worked freelance with the National Endowment for Science, Technology and the Arts (NESTA) facilitating and evaluating museum/technology/art workshops. These experiences developed my understanding of learning outside the classroom. I subsequently taught year 4 as a class teacher in London, maximising the chance to use the school pond for a Wildlife Club. In science lessons we held science conferences as a way to develop children's confidence in scientific language, after showing children how my family (biochemists) explained their research to potential collaborators.

I enjoyed working with young people in the classroom, but when the opportunity arose I took a job as Education Manager on a boat: the West London Floating Classroom on the Grand Union Canal. Known as the 'green lung of Hillingdon', it was hugely rewarding to design programmes to meet teachers' requirements; for example, we turned the boat into *HMS Beagle* for 300 KS2/3 pupils from Hayes in Science Week, not forgetting the 1832 Naval costume for Captain Fitzroy. The post was Heritage Lottery funded and based at Groundwork in Denham Country Park, so through that I also led nature based Quarry workshops (Aggregates Levy funded) and Sustainable Schools continuing professional development (CPD) sessions about biodiversity, from the boat, in Southall.

I was subsequently lucky enough to get a post at the National History Museum, London (NHM) developing learning programmes, and through this employment developed a live animal show, and was involved in delivering specimen handling workshops, wildlife garden activities, digital learning opportunities, festivals, online materials and gallery resources. I completed a part-time Masters in Museums and Galleries Education, based at the Institute of Education, in order to develop my understanding of the theories behind museum learning. Representing NHM at meetings developed my knowledge of the natural environment sector. In January 2011 I was awarded a Winston Churchill Travelling Fellowship to investigate learning in natural history settings. Through attending the conference ‘Science across cultures’ in South Africa and visiting natural history settings in Australia and New Zealand, I furthered my understanding around education about the natural world in a wider range of contexts.

I have taken part in, led and organised teaching about living things and their environments in a range of scenarios in the UK. Therefore, this research acknowledges the experience above and a Western viewpoint. Observation suggests that conversations, narratives and assumed aims differ markedly in each biodiversity setting. I became interested in how these aspects affect what pupils gain from different informal science settings outside school, when they go to learn about animal and plant habitat and adaptations. Previous experience has developed my practical understanding of the subtleties of learning in varying biodiversity settings, largely in the UK. The literature review (Chapter 2) examines the nuances of learning about biodiversity in different ways, with a theoretical lens.

Common sense would suggest that pupils respond differently to being outside, meeting live animals and handling specimens. Are there benefits for pupils when they learn about habitats and adaptations in different ways? Environment exploration, natural history specimen handling and live animal experiences have become accepted informal science education formats, and are marketed to teachers as addressing the same curriculum aims of developing habitat and adaptation subject knowledge. Do pupils benefit differently from encountering biodiversity in these different ways? Do pupils gain any benefits at all from informal biodiversity experiences? The literature review in Chapter 2 will consider the context, aims and practice of the three formats and relate this to potential benefits for pupils in terms of messages that may be conveyed in different settings.

Chapter 2 Literature Review

2.1 Teaching and learning

> Children respond to 'real' objects in a way they do not respond to other things, the 'real' means something very special to a child.
>
> (Kelly and Wray, 1975: 11)

Despite the age of this quote, the sentiment still stands. Why are real experiences about biodiversity important for children? What can children learn in real contexts or with authentic objects? As described in Chapter 1, the justification for the research question 'What do children learn about biodiversity in informal learning settings?' includes evidence from informal educators who recommended increased pupil access to real experiences. This literature review is intended to present relevant arguments and theoretical perspectives, taking into account both indoor and outdoor learning. The question of what children learn about biodiversity brings insight into how they might learn about biodiversity, and this is an area for future research which arises in Chapter 6. Therefore, theories of learning are covered in this literature review.

Research from the fields of formal science education, informal science communication, museum and visitor studies and environmental education (and synonyms) are identified and discussed in this chapter. The search terms that were employed were 'museum or natural history or environment or biodiversity or sustainability or ecology or zoo or live animals' and 'education or learning or school or teaching or pupil or children or activity', and searches were carried out using the Institute of Education's library search facility. References were selected when they met criteria of being about a) primary pupils, b) informal learning and c) the natural world. Figure 2.1 illustrates the resultant areas of research.

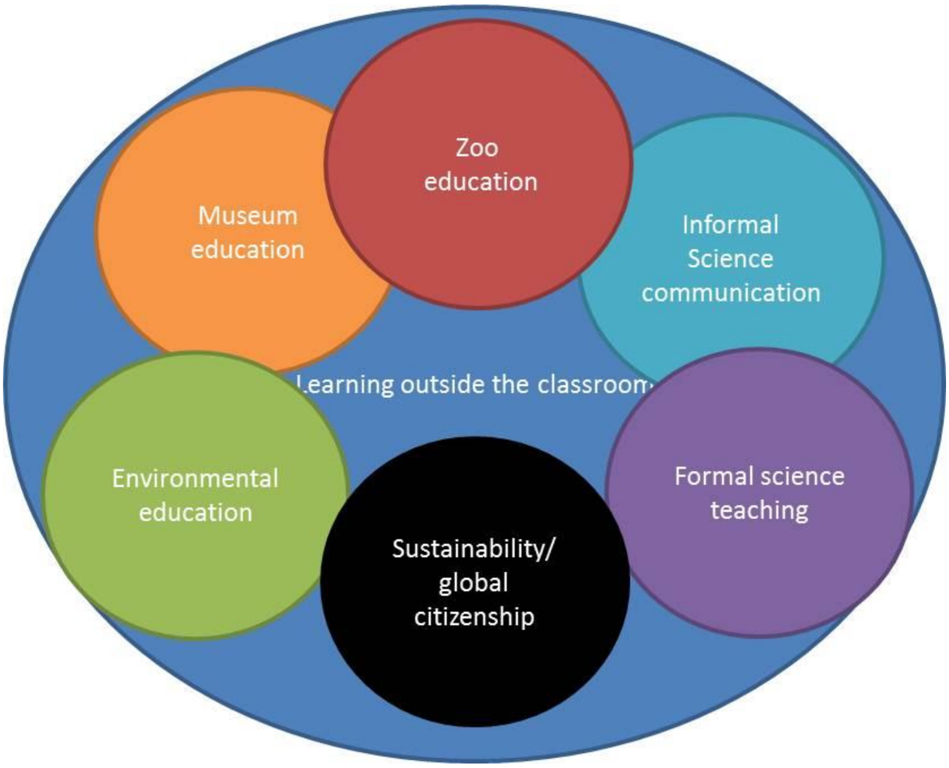


Figure 2.1 Fields of research identified (in October 2010) through a literature search as being relevant to this study

Figure 2.1 shows that the fields of research which were identified through the literature review are Museum education, Environmental education, Sustainability/global citizenship, Formal science teaching, Informal science communication and Zoo education.

This literature review is organised into four main Sections, about teaching and learning; environmental education; education with live animals; and museum education using natural specimens.

2.1 How do children learn?

Pedagogy is the study of teaching, and understanding how children might learn is central to this study. Reviewing developments in pedagogy, three broad theories relevant to science education are apparent: behaviourism, cognitive constructivism and sociocultural theory. Pavlov (1927) and Skinner (1935) developed behaviourist theories through experimenting with animal responses to stimuli, around the start of the twentieth century. The main tenet is that repeated paired associations result in long-term neural change. Whilst neurobiologically sound, behaviourist learning pedagogies (rote learning and repetition) have been superseded by more nuanced pedagogies that conceptualise the learner's internal frame of reference. Piaget (See 1926, 1932 and 1955 for key works) is well known for elucidating *constructivism*, an active theory of learning stating that children's thinking develops through interaction with objects and phenomena (Bliss, 2008). The nature of this interaction and the resulting change in ideas is characteristic of age. Piaget identified stages of learning (0-2 years *sensorimotor*; 2-7 years *pre-operational*; 7-11 years *concrete operational*; and 11-16 years *formal operational*). For example, the ability to form abstract concepts based on observation would be most likely in the formal operational stage. There have been a number of criticisms (for example see Duit and Treagust, 1998; Santrock 2008) of the precise nature of the stages. Critics of Piaget suggest that the stages underestimate children's ability, do not always proceed sequentially, and are based on the sample of Piaget's own three children. However, it is important to acknowledge constructivism as a foundation of this research, in that children's new learning is acknowledged to build on previous experiences.

Sociocultural theory goes further and defines the role of social interactions and context in influencing learning. Vygotsky (1978) highlighted the importance of language in learning and proposed that children can learn from experts within their Zone of Proximal Development (ZPD). These experts may be teachers or peers. Crucially, the level of cognitive challenge (new concept, skill, value) presented via language must be only slightly more complex than the child's existing competences otherwise frustration will result, rather than learning. The context in which the learning is taking place is an important factor as it influences higher level processing. There are a number of debates around Vygotsky's work; see Gredler (2012) and Murphy (2012) for discussion. This research takes a sociocultural view of learning and considers that situations where peers (and adults) can engage in conversation are conducive to learning. Sociocultural learning theories are central to both informal science and museum theories of learning as explained in Tal and Dierking's review article (2014) 'Learning science in everyday life'.

These are the foundations from which other theories of learning have developed. These include Bloom's taxonomy of educational goals (1956), Gardner's multiple intelligences (see Gardner, 2003 for a retrospective) and Hein's conceptual framework for the interrelationship between theories of knowledge, theories of learning and associated pedagogies (1998). Hein's work is most relevant to this research and is covered in further detail subsequently.

2.1.1 The Learning Process

According to Bruner (1990), constructing meaning is a social activity; conversations have a cultural context. How does this apply to biodiversity education? One clear example would be to consider animals such as pigs and cattle, which are viewed differently by members of different religions. However, in 2003, Rickinson's review of environmental education research identified the importance of the cultural context as a gap in research. Lundholm et al. (2013) have addressed this when they examined the environmental learning process, thinking about how students view particular aspects of subject matter, and how they feel about the subject matter, particular tasks and their learning more generally.

Wals and Dillon (2013) ask the question: What do theories of learning offer environmental education research and its users? Understanding the processes by which children learn gives insight into effective teaching strategies.

A key process children go through in order to learn names is **categorisation**. This involves forming a concept of an animal as a result of experience and repeated pairing of stimuli with a spoken or written label (the animal's name). This is called an exemplar in learning psychology (Smith and Medin, 1981), and it is refined through ongoing experience. When children see a new species, they may modify an existing exemplar or create a new one, depending on the degree of mismatch (cognitive dissonance) they perceive between their prior and new knowledge. The architecture of exemplars is categorisation. Bruner, Goodnow and Austin explained:

> The learning and utilisation of categories represents one of the most elementary and general forms of cognition by which man adjusts to his environment.
>
> (1956:20)

Markman (1989) details the cognitive process. For a child to acquire a concept they require:

1. An analytic view to break the holistic view of the concept into its component properties.
2. A defined hypothesis testing system that when faced with new exemplars generates possible properties, evaluates the properties against new exemplars, and revises, rejects or maintains a concept.
3. An ability to use criteria to evaluate novel objects to determine whether they are members of a category.
4. Learners therefore need to know the constituent parts needed for membership of a category (Rosch and Mervis, 1975). They need more specialist knowledge of what is important and finer detail in understanding discriminatory features. It could be compared to a giant game of 'spot the difference'.

Given that the process of learning involves comparison of new information with prior knowledge (leading to adaptation and assimilation or, alternatively, rejection), an appreciation of prior knowledge is necessary for understanding children's learning about biodiversity. Children might have experience of visiting zoos, aquaria, science centres or botanic gardens (Bell et al., 2009). How do young children view living things? Piaget (1926) stated that they have the following understanding:

> Stage 0: 0-5 years – No concept of living.
>
> Stage 1: 6-7 years – Things that are active in any way, including making noise, are said to be living.

Stage 2: 8-9 years – All things that move, and only those, are said to be living.

Stage 3: 9-11 years – Things that appear to move by themselves, including the sun and rivers, are said to be living.

Stage 4: Over 11 years – Only animals and plants are said to be living.

Research subsequent to Piaget showed that younger children use criteria of movement for living things (Osborne et al., 1992) and older children use criteria of nutrition (Lucas et al., 1979). It is important to note that critics point out that these stages do not hold true for non-Western cultures (Chapman, 1988).

Patrick and Tunnicliffe (2013:97) identify a number of types of discourse/questioning used by educators when teaching children at animal exhibits. (1) Focusing, e.g. 'Look, what about these?'; (2) Informing; (3) Developing learning through questioning, e.g. 'Why do you think its eyes are in the front of its head instead of on the sides of its head?'; (4) Assessing what the child is thinking, e.g. 'How do you know?' (This could also be interpreted as prompting the child to make connections.); (5) Interpretive assisting others in understanding, reasoning and justifying comments or names; (6) Feedback "includes behavioural feedback as well as confirmation", recollecting school teaching; (7) Terminating, i.e. closing the conversation: "time to go". Teachers are apparently particularly good at this!

De Witt and Hohenstein (2010) showed that student autonomy is important for affective learning outcomes, so exploration does not always have to be guided by an adult. This contrasts with early comments by educational reformer Rachel Carson (1965) in *The Sense of Wonder*: "a child needs to have an adult who is interested in order to find delight". Although environmental education thought leader Rachel Carson's key works were published in the 1960s, some of her comments about inspiring children rather than filling them with facts are particularly pertinent to the internet age. Now, children do have access to information, but need to want to seek it out. This would suggest that the affective domain of emotion, such as positive motivation, is also an important aspect to consider.

In addition to learning as defined in the fields of cognitive or educational psychology, described above, the findings of this research will be related to learning at a neurobiological level. Having studied experimental psychology and neurobiology as part of my Natural Sciences degree, I am interested in the possibility of relating findings to underlying changes in cells. Factors in informal learning environments which might increase salience will be suggested in the discussion and conclusions; see Section 6.7. It is therefore relevant to consider the neurobiology of learning in this literature review.

Neurophysiology of Learning

At a neuronal level, making new connections is a precondition for learning. This is achieved through making new synapses (new connections between neurons). The brain contains billions of neurons that can connect in a myriad of different ways. When a link is made between one neuron and another, vesicles of neurotransmitter travel between the two neurons. The more times this happens, the easier the route becomes. An established pathway becomes learnt. The way a connection becomes established is through Long Term Potentiation, a change in the neuron firing required to cause vesicles of the relevant neurotransmitter (dopamine in the case of emotional responses) to cross the gap between two neurons (Bear et al., 2007).

So, learning requires new connections, synapses, to be made. Repetition of experiences cements learning by continuing to make the connection between neurons more likely. In certain states, new connections are easier to make. The term 'neural plasticity' refers to changes in neural pathways and synapses which are due to changes in the environment, behaviour and neural processes, as well as changes occurring after injury. One of the states that promotes neural plasticity is being in new environments, for example when learning outside of the classroom for someone whose school learning typically takes place in classrooms. An example of recent evidence for this comes from Flight (2013) who provides neuroscientific evidence to indicate that environmental enrichment promotes adult neurogenesis and synaptic plasticity in certain species. This work was carried out with the hope that it could be applied to neurogenerative diseases, but it can also be applied to environmental enrichment in other contexts such as informal learning.

One way to illustrate this heightened sensory perception and alertness in new situations is by considering a journey to a new place. Frequently, the journey there seems longer than the return journey. This is because neurons are firing more frequently as new stimuli are encountered, altering the apparent perception of time. Since there are more impulses than average, one thinks that more minutes have passed. However, on the way back, the background has become ‘wallpaper’ and does not elicit an increased rate of neuron firing; therefore, the time seems shorter.

Neuropsychology of learning

Jarvis (2009) notes the historical definition of learning: learning is a change in behaviour, although it would seem that learning in fact causes a change in behaviour. More recently, and more useful for the purposes of this theory (though learning can take place in non-social situations), Jarvis and Watts (2012) propose that learning is:

> The combination of processes throughout a lifetime whereby the whole person – body (genetic, physical and biological) and mind (knowledge, skills, attitudes, values, emotions, meaning, beliefs and senses) – experiences social situations, the content of which is then transformed cognitively, emotively or practically (or through any combination) and integrated into the individual person’s biography resulting in a continually changing (or more experienced) person.
>
> (2012:3)

This overview of neurobiology and pedagogy underlies specific theories for environmental explorations and museum-based learning, presented subsequently. The next sub-Section will explain the formal education setting in England and show how biodiversity education is covered in curriculum requirements.

2.1.2. Children learning about biodiversity in school

Formal science education is defined here as teaching about science in schools. School curricula determine the informal science education experiences that teachers can justify their classes participating in during school time. This Section will show the position of education about the natural world in the English curriculum, and contrast this to other UK countries' curricula for appreciation of alternative ways of segmenting concepts. This research focuses on primary children, specifically those in Year 4 (age 8-9) in England.

The unit 'Habitats and Adaptation' was specified as a Qualifications and Curriculum Authority (QCA) unit from 1997 until 2008, and the knowledge and skills covered by this unit are relevant to this research. Whilst new curriculum guidance was being developed, following a period of governmental change in England (2011-2013), many teachers still used QCA units as a starting point for creative curriculum planning. The following curriculum content is statutory, but no longer tested externally, for science in Key stage 2 (7-11):

> **Variation and classification**
>
> Pupils should be taught:
>
> - to make and use keys
> - how locally occurring animals and plants can be identified and assigned to groups
> - that the variety of plants and animals makes it important to identify them and assign them to groups.

Living things in their environment

Pupils should be taught:

- about ways in which living things and the environment need protection

Adaptation

Pupils should be taught:

- about the different plants and animals found in different habitats
- how animals and plants in two different habitats are suited to their environment

Feeding relationships

Pupils should be taught:

- to use food chains to show feeding relationships in a habitat

(http://curriculum.qcda.gov.uk/key-stages-1-and-2/subjects/science/keystage2/ accessed 20 Nov 2011)

The Department of Education was undertaking a curriculum review at the time of writing this literature review. Figure 2.2 shows that traditional subject boundaries are used in England and Wales, whereas the more recent Northern Irish and Scottish curricula allowed for a more thematic approach with interdisciplinary learning. For example, 'The World Around Us' features in Northern Ireland, as opposed to Science and Geography in England.

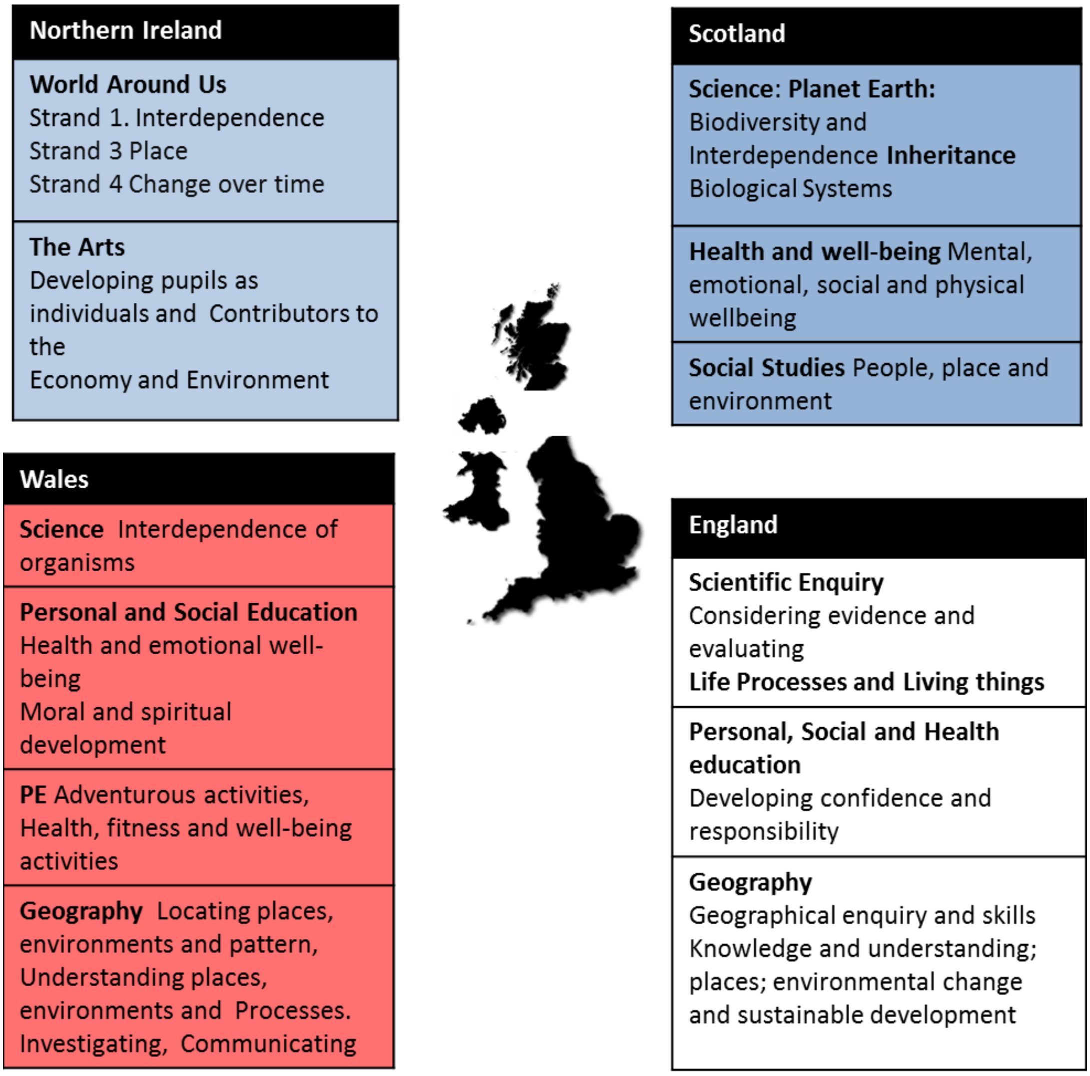


Figure 2.2 Topics relating to informal learning about habitats and adaptation within the primary school science curricula of the four UK nations, in 2012

The English National Curriculum dates from 1988, but has been reformed several times since then. In particular, the Rose review of the primary curriculum was nearing its final stages in 2009. It took a cross-curricular approach, and included evolution as a topic at Key Stage 2 (7-11). At the time of the Rose review, the concept of ‘Evolution’ was introduced at age 14-16. However, the Rose review was not pursued (despite extensive consultation with education professionals) after the Conservative-Liberal Democrat Coalition took over from Labour in May 2010. A subsequent curriculum review has now been completed, with a new Primary Curriculum due to be implemented from September 2014. ‘Evolution’ is now included as a concept for pupils in Upper Primary (ages 9-11). The concept of

‘Evolution’ is used in this thesis as an example of content relevant to biodiversity teaching, where the level of understanding required has increased; this could provide opportunities for informal education settings to support non-science specialist primary teachers who have to teach science.

The Organisation for Economic Co-operation and Development (OECD) held a workshop for international teachers in Cromer in 1994, with the aim of embedding politically agreed biodiversity principles into national curricula. England and Wales opted to be observers, rather than participants (OECD, 1994). This may be one reason contributing to the differences in curriculum organisation approach. The Scottish curriculum clearly outlines progression in understanding Biodiversity and Interdependence (see Appendix 1). Teaching about nature often crosses traditional subject boundaries; therefore, it could be argued that interdisciplinary curricula are appropriate for effective teaching about the environment. Interdisciplinary learning suits biodiversity topics well owing to the definitions and perspectives about biodiversity education explained at the start of this chapter. The discussion in Chapter 3 will start to address what effective teaching about the environment should achieve for pupils, based on pilot study results.

The current aims of school science education are twofold: to inspire children to pursue careers as expert scientists, and to increase scientific literacy for pupils who will not study science beyond GCSE (Harlen, 2011). ‘Big ideas’ that are necessary to make informed choices throughout life are the subject of discussion about how pupils can best progress towards real understanding of science (Harlen, 2011). Themes in science education research have progressed towards considering a range of non-traditional pedagogies for teaching science; for example, role play for younger pupils and the chance to debate ideas for secondary pupils (Osborne and Dillon, 2010). Research has shown that opportunities for genuine open-ended inquiry are beneficial for learners (Harlen, 2008). Since the introduction of the National Curriculum, Standardised Assessment Tests (SATs) were used to record science performance at age 11, and were used in league tables to compare school performance. A number of science educators campaigned for SATs in science to be abolished (which happened in 2010), with the aim of reducing teaching to the test which was felt to be taking away pupil enjoyment in science (Collins et al., 2010). However, an unintended outcome has been the extent to which science has been de-emphasised in primary schools, in order to focus on literacy and numeracy for SATs tests (Wellcome Trust, 2013).

2.1.3 Children's ideas about habitats and adaptations

This research takes the epistemological viewpoint that children's common conceptions are essential 'background' information for planning and interpreting their learning about the natural world, in situations that range from formal school teaching to informal science communication activities. This sub- Section will link formal and informal settings by showing that they both influence conceptual, process and attitudinal stages of children's learning.

Looking at common misconceptions is an established way of understanding children's concept development. Classifying vertebrates and flowering plants is a challenge for children, according to Schofield et al. (1984). The concepts 'species' and 'breeds' led to confusion in 5-16 year olds in a study by Leach et al. (2007). Tunnicliffe and Reiss (1999a) researched pupils' abilities to identify and classify native and non-native species, with young people aged 4, 8, 11, and 14 years. They found that pupils were increasingly able to name species as they got older, and they were more likely to comment on habitats and behaviours as they got older. The sources of their prior knowledge (n = 36) were home, direct observation, media, school and books in descending order of frequency. There was some evidence of gender differences; for example, boys were more likely to say that they had learnt from books, consistent with boys being more likely to read non-fiction. Pupils used salient features to classify animals, but showed limited ability to group animals scientifically. They were able to name the animals, which Tunnicliffe and Reiss (1999a) suggest is based on the tendency of science lessons to focus on naming and labelling.

Interdependence refers to the way that living things are interconnected and rely on one another for food and shelter. Leach et al. (2007) found that a major problem was knowing which way the arrows on trophic levels go; pupils linked producer and plant, consumer and animal without thinking through specific situations. The researchers found that children made simple statements such as 'birds live in trees' around age 13, but that there were no clear stages in ecological understanding beyond 13. In contrast, Gayford (2008) found stages in ecological awareness. He presents longitudinal findings of pupils' perspectives about sustainability, using the eight sustainability 'doorways' established by DCSF in the Sustainable Schools Framework (described in Section 2.1). Working with fifteen schools over three years, he found that there were common conceptions, and that children's ideas did show progression in knowledge and process understanding. One aspect he examined in detail was the concept of biodiversity. Four stages of pupil understanding have been summarised below:

> Stage 1: There is a growing recognition that forests are places where animals live. The importance of conserving wildlife is mainly in anthropomorphic terms such as '*you would not like it if you were made extinct.*'
>
> Stage 2: Diversity, particularly biodiversity, is still largely considered in terms of endangered species, with emphasis on large and exotic animals in distant places. However, habitat preservation is more firmly established as a supporting concept in maintaining biodiversity. Pupils appreciate the significance of the development of special areas in the school grounds or locally that encourage diversity of flora and fauna, but they don't really make links with sustainability.
>
> Stage 3: Diversity is still seen largely as a matter of biodiversity, with more emphasis now on the maintenance of habitats that will sustain diverse animal and plant populations. The damaging effect of international trade, particularly in activities such as logging, are seen as an important factors, with less

awareness of the need to develop effective agriculture in areas where animals are endangered. This especially centres on tropical environments. Thus, connections are more widely appreciated between different aspects of environmental protection, and the consequences of different actions are more clearly understood. There is a growing link being made between 'ethical' matters and activities that promote sustainability.

Stage 4: Connections are seen between many more factors related to the environment and these are closely related to the consequences of actions. For example, the matter of conservation of elephant populations in Africa, their role in encouraging tourism, their destructive behaviour towards local human populations and the possible negative impact of tourism.

(Gayford, 2008: 19)

It is not clear whether the increase in ability to understand multiple viewpoints is age-related or a product of curriculum content. Likewise, although there are common conceptions about nature, Reiss et al. (2007) assessed teenagers' representations of given common species and demonstrated diversity in responses. They use this evidence to assert that the unitary view of science will not be relevant for all pupils, and therefore emphasise the need to teach science in a way that acknowledges a plurality of viewpoints, in order to increase pupil engagement.

In terms of process around biodiversity conservation, Gayford (2008) described four stages with a spectrum of increasing personal agency: being involved in small scale wildlife garden projects under guidance; taking increasing ownership with the teacher as leader; participating in ambitious projects such as pond creation; and monitoring environmental changes with a view to initiating future change. Interestingly, Driver (1994) states that young children seem unable to consider the environment without human intervention.

Xuehua (2004) in China looked at elementary school pupils' prior attitudes to the environment and stated that they can be characterized by the Chinese phrase "man's nature is good at birth". Pupils are emotional and have a natural attraction towards nature, including mountains, water, animals, and plants. This is similar to the concept of biophilia (Wilson, 1984). Children also show affection for small animals, relatives and friends. In contrast to Reiss and Tunnicliffe, Xuehua found that school was the most important source of information for elementary school students. Similarly to Reiss and Tunnicliffe (1999a), the media and family were also frequently cited as sources of information. Xuehua concludes "we should arrange our environmental education classes based on their existing knowledge base" (2004:47), which is consistent with the constructivist learning theory approach previously outlined.

This section has shown evidence of stages in children's learning about the disciplinary concepts of living things, classification and interdependence. The majority of the available data looks at progression in the knowledge domain of learning, as opposed to attitudes or values, for example. The sources of children's prior understanding are direct experience, for example in informal learning environments, school, home and the media. The next Section will consider informal learning theory.

2.1.4 Children learning about biodiversity in informal settings

In order to understand the scope of the term 'informal settings', it is necessary to define 'formal education' as the term is being used in this thesis. I refer to formal education activities as those which take place inside the classroom, in a school. I refer to informal education activities as those taking place with organisations that provide opportunities to enrich learning through experiences outside the classroom. Bell et al. (2009) describe the study of informal science education settings as an emerging and fast growing field. Whilst I focus on school pupils taking part in structured sessions, it is nonetheless relevant to consider literature about informal settings with a range of audiences.

Falk et al. (2011) use axes which show degrees of public science, technology, engineering and maths understanding and informal education to describe a landscape of types of informal science learning. Their Figure, shown here as Figure 2.3, is a helpful visual illustration of the range and scope of informal science education. In the English context, university science fairs would also be included as sources of informal science learning. Most relevant to this study are natural history museums, zoos/aquaria and parks/gardens.

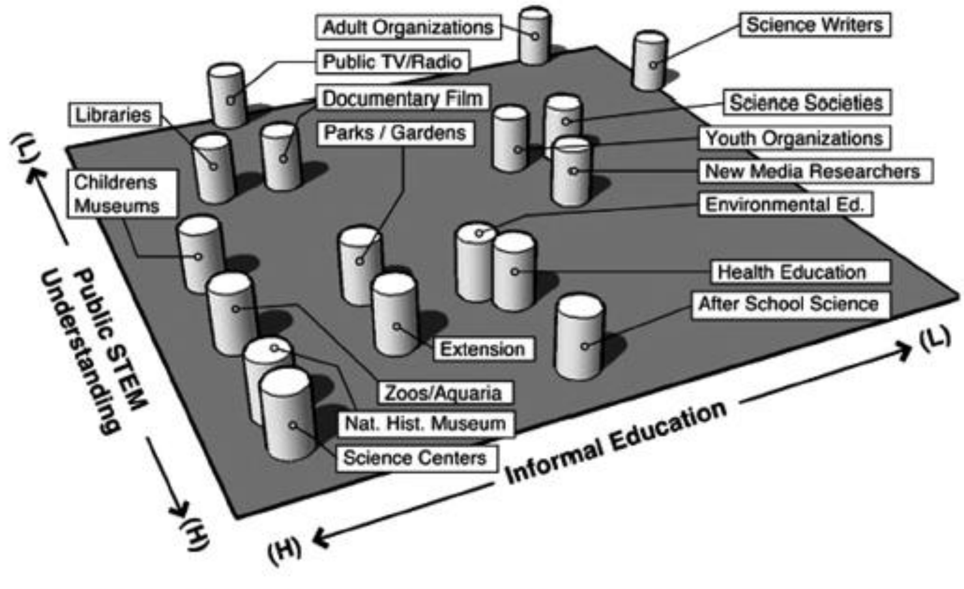


Figure 1. Two-dimensional representation of current ISE landscape as a function of identification with informal education as an educational process and public understanding of STEM as an educational goal.
Note: Axes are qualitative scales representing "High" (H) to "Low" (L) importance.

Figure 2.3 A 'landscape' of informal science learning types, used here to show that children could learn about biodiversity in a wide range of settings (Falk et al., 2011:1)

Robert Winston's introduction to *The Public Value of Science – or how to make sure that science really matters* (Wilsdon et al., 2005) describes the 'watchwords' of informal science communication as dialogue and engagement. Citing suspicion of science as a central issue to address, the report suggests that individuals in developed countries are most likely to view science and technology negatively:

> How do we reach a situation where scientific 'excellence' is automatically taken to include reflection and wider engagement on social and ethical dimensions? (Wilsdon et al., 2005:19)

Young people should be in a position to understand scientific developments and to offer a viewpoint on controversial issues. Wilsdon's report (ibid.) outlines the perceived gap between 'social' and 'real' science, i.e. between everyday applications of science, not using specialist vocabulary; contrasted with processes and knowledge which scientists describe using specific language in labs. Wilsdon uses an example of China's environmentally active Non-Government Organisations to show that public engagement in science can be positive for scientists and the environment. Different cultural approaches to decision making, in particular respect for traditions, are given as examples of practice that the UK needs to pay attention to. Dickinson et al. (2012) explain that it is important to see scientists and the public as integrated rather than separate entities. There are clearly issues with a binary scientist/non-scientist classification. Citizen science is an important concept in informal science education (Irwin, 2002), meaning projects where the public collect data with the aim of either contributing to evidence in experiments (e.g. species distribution) or developing their own scientific skills and attitudes. Irwin explains that it is useful to avoid a deficit model of the public view of science and cites environmental risk as an example where public opinion is embedded in decisions.

An English example relevant to biodiversity education is Natural England's work to encourage positive attitudes around Marine Protected Areas in the Jurassic Coast in Dorset, in 2009. Front end consultation showed negative attitudes with murky seawater; therefore, the concept of underwater landscapes was focussed on and informal creative science activities were offered at events to increase positive perception of Marine Protected Areas (source: attending Defra SIG EPU biodiversity Spring 2009, hearing plans and subsequently observing NE activities taking place at Lyme Regis). One example is an annual Fossil Festival (2009) in Dorset which 13 000 visitors attend each year. Internationally, there is a comparison: Dimopoulos et al. (2008) present an example of turtle conservation in Greece. A sea turtle rookery in Zakynthos Marine National Park needed protection and the ability of this to happen depended on positive local attitudes. They state that it is vital to engender positive attitudes in the general population, starting at early education stages.

Why is this relevant to children learning about nature? Using models of progression in children's understanding (for example, Barker and Slingsby, 1997), it is clear that basic understanding of the components of an ecosystem are the foundations for understanding interdependence and how environmental interventions could lead to specific consequences. OPAL (Open Air Laboratories Projects) are an example where children are participating in citizen science projects, developing their concepts of ecosystems. A key trend is the role of technology in facilitating people in the collection of scientific data, for example Wildkey or Natural History Museum identification mobile apps. One area of debate is the extent to which this can provide accurate data which can be used by scientists; citizen science may have more value for the citizen participant in developing skills and engendering changes in knowledge, attitude and skills (21st century learning in natural history settings forum, February 2012).

Investment in public engagement in science has led to new formats for informal science learning, for example Science Festivals such as the Fossil Festival previously described. These annual celebratory events where a range of science staff speak with visitors have been shown to have positive outcomes for science learning (for example Cambridge Festival of Ideas external evaluation report: Jensen, 2011). This format is starting to be used in school workshops, for example the Wildfowl and Wetlands Trust International Year of Biodiversity festival. This example was submitted as a case study in response to the survey I circulated in Jan 2011 (described in Section 1.2). The Natural History Museum held a Life Science Fair for pupils as part of the European-funded 'Researchers' Night', blending the fields of informal science communication and formal education workshops. Borrini-Feyerabend (2000) shows the importance of schools as sites for informal science communication to a range of audiences around co-management of natural resources. Therefore, schools and informal settings can host informal science education and communication activities. It is clear that the boundaries between formal and informal science education can be blurred.

This section has given an overview of key ideas in informal biodiversity learning. The next section looks at the theory of children learning about biodiversity through exploring the environment.

2.1.5 Creativity and Learning outside the classroom

Vygotsky's teaching acknowledged that opportunities to learn outside the classroom are rich sources for creative learning experiences (Holzman, 2008). Holzman considers the relationship between learning in school and out of school, when considering how Vygotsky's theories have been used in designing out of the classroom learning experiences. Vygotsky's text 'Imagination and Creativity in childhood' (2004) explains his view that the brain can carry out two types of activity; reproductive and combinatorial or creative. Whilst reproductive behaviour allows the storage of memories, then creative activity is the reworking of experienced elements in a new way to create novel representations. These can be intangible, such as thoughts, or tangible such as artwork, writing, film or poetry. They may be imperceptible to others, or they may be creative activities enacted through movement such as children's role play activities. These imaginative activities are vital to people being able to influence their future, according to Vygotsky:

> If human activity were limited to reproduction of the old, then the human being would be a creature oriented only to the past and would only be able to adapt to the future to the extent that it reproduced the past. It is precisely human creative activity that makes the human being a creature oriented toward the future, creating the future and thus altering his own present.
>
> (2004:9)

Out of school experiences are opportunities to allow children to gather novel experiences in new environments, and are a rich source for imaginative and creative responses. The flexibility in structure which is often a feature of out-of-the-classroom learning experiences allows opportunity for children to explore new environments, and to compare their imagination of visiting new spaces with reality. In inner London the opportunity for children explore new environments freely is reduced compared to rural areas, owing to the perception of a lack of safety in cities. Therefore, playing in safe, novel environments such as in a museum or environment centre is important for children's creative development.

It is important to note that this thesis focuses on out-of-school experiences which take place during school time. This contrasts with out-of-school experiences which take place after school and at weekends. The key difference is one of access; there is a monetary barrier to children participating in activities out of school time, whereas this thesis looks at school trips which are provided for an entire class during the hours of the school day, regardless of parental income. Supplementary education (Gordon et al., 2005) and complementary learning (Caspe and Lopez, 2014) are terms used to describe rich and varied out-of-school experiences, and considerable research has been undertaken into those aspects which are particularly effective at allowing opportunities for youth development. Holzman acknowledges a theme which is also discussed in Section 2.2: that out-of-school-time programmes are under increasing pressure to demonstrate gains in performance within formal assessment. The examination agenda threatens to negate the potential opportunities for enrichment of these out-of-school experiences which are summarised as follows:

> the positive change in young people's attitudes to one another from learning and creating together as a group; (and) the opportunities that young people have to learn from and build positive relationships with successful adult professionals
>
> (Holzman, 2008:69)

Social development is emphasised, and this can be correlated with young people extending their abilities within the Zone of Proximal Development (Vygotsky, 1978). Instead of focussing on exam attainment, another perspective from which out-of-school programmes have been researched is the way that they allow for personal development, in terms of social, emotional, cultural and intellectual maturity and citizenship. This view is consistent with the EarthSmarts socio-ecological literacy framework (Nichols and Zeidler, 2012) which will be referred to as a framework for analysis in the Methods chapter. Some of the ways in which this take place in out-of-the-classroom learning environments are through play and performance, for example taking on new roles, with young people moving out of their comfort zones and becoming experts, leaders, team supporters etc. Amos and Richardson's work at the Olympic park's Viewtube education site (2012) can be seen as an example of a scenario in which young people had to work together and find consensus about park development, taking on the identity of people who stood for different viewpoints. Falk et al. (2008) have recently begun to focus on the importance of identity in informal science education. However, it is not only through meeting new people and interacting in novel situations with peers that allows young people to explore their potential within the zone of proximal development. Fogel et al. (2014) explain that play is a zone of proximal development; when children represent social rules and manipulate them in novel ways, they are preparing for taking an active role in society. I would also add that solo exploration of novel settings, as well as exploring with others, fuels children's imaginations and in the same way allows them to gain experiences linking actions to consequences within different settings, which lays foundations for thinking flexibly in adult life.

In 2002, Pekrun et al. noted there was a tendency to omit emotions from educational research, particularly grief, despair or anger. In contrast, the MLA framework 'Inspiring Learning for All' (which was used as the basis for the pilot study research, as described in Chapter 3) includes the domain 'Enjoyment, Inspiration and Creativity'. However, negative emotions are again not included. There is increasing interest in the role of emotion in learning; a popular framework in zoo learning in the UK is Social and Emotional Aspects of Learning (SEAL). Goleman et al. (2012) make a powerful case for the importance of emotions in their article *Ecoliterate: How educators are cultivating emotional, social and ecological intelligence*. Lundholm et al. (2013) state that "learning is a very personal cognitive and emotional process and that research, so far, has only begun to identify what learning is and what it feels like" (p.240). They explain that differences between educators' and researchers' personal and professional emotional responses may be an issue; likewise the power relationship between teachers and learners.

Zeyer and Kelsey (2013) provide evidence supporting the significance of emotions, both for short- and long-term outcomes, in their paper ‘Environmental education in a cultural context’:

> we contend that emotions are of primary importance practical importance in environmental education … engagement and achievement, personality development, health and wellbeing’.
>
> (2013:206)

They reference work by Harré et al. (1986), acknowledging that emotions are embedded in the beliefs, norms, values and expectations of culture; therefore, emotional responses may be learnt at an early age. For example, the response of a Muslim or Jewish child to seeing a real pig or related specimen would be likely to be very different to a pig farmer’s child. In addition, Aikenhead (1996) states that cultural responses may be at odds with Western scientific views, which are prevalent in the London context in which this research was carried out. The concept of cultural border crossing refers to children having to take on the viewpoints of a different culture as part of education, which may involve encountering a different set of emotional responses, perhaps at odds with those demonstrated by their families. Aikenhead brings this idea into the open by giving it the formal name ‘cultural border crossing’ as it is something which educators who hold the prevailing viewpoints may not be aware of. This is particularly likely to be the case if they have not undergone formal teaching training, in which many teachers are taught to reflect on their own cultural contexts and assumptions and consider the impact of these for their future pupils.

2.2 Environmental education

> Nature holds the key to our aesthetic, intellectual, cognitive and even spiritual satisfaction
>
> (E.O. Wilson, 2012)

In order to understand the reasons why pupils might take part in an environmental exploration, perspectives about the aims of outdoor nature education will first be considered, followed by reflection on pedagogy. For the purposes of this study, an environmental exploration is a practical activity of varying duration where pupils are encouraged to observe naturally occurring living species outdoors, in a habitat or habitats with a range of degrees of urbanisation.

2.2.1 Aims of environmental exploration

There are a number of theoretical fields that have contributed to the aims and pedagogy of environment exploration activities over time. Nature Study in the early 1900s (Sheppard, 1905) preceded Environmental Education (1948), and a process that parallels speciation has led to such apparent synonyms as Conservation, Ecological and Biodiversity education/literacy/understanding/learning (Palmer, 1998). Lucas (1979) stated that the essence of environment education was being 'in, about and for the environment'. McCrea (2005) reviews the US history of environmental education and concludes that there are five objectives: awareness of and sensitivity to environmental problems; basic knowledge and understanding of how the environment functions; positive attitudes and values towards the environment; skills to identify, investigate, and resolve environmental problems; and active participation in environmental protection. Kassas (2002) lists the three aims as: public and workforce skill development (based on UNESCO, 1975); developing a worldview of humans' relationship with the environment; and an active citizenship component. Kassas proposes that the main problems are defining spaces, the definition of ecology and taking multiple views into account. Metzer et al. (2009)

analyse environmental education using Popper's three domains of the physical world (the environment), the mental world (subjective knowledge) and objective knowledge (products of the human mind). Metzer's article aims to demonstrate that the expansion of the physical world in terms of physical and digital access makes new demands on the scope of environmental education.

How can these differing models be synthesised? In fine-grained detail, Sauvé (2005) proposes 15 themes or 'currents' underlying environmental education which will be used here to indicate the scope for circumstances under which environmental explorations are used to enrich pupil learning. The first group of themes (Naturalist, Conservationist, Problem-solving, Scientific, Humanist and Value-centred) are seen as traditional approaches and the second group of themes (Holistic, Bioregional, Praxis, Feminist, Ethnographic, Eco-education and Sustainable development) are new approaches.

Firstly, the Naturalist current is spiritual and experiential. This resonates with my own experience of John Muir conservation projects. The philosophy of engendering positive affective connections with the environment belongs in this current. Louv's (2006) popular US parenting book *Last Child in the Woods* aligns with this view by advocating the need for children to be allowed the freedom to form emotional connections with the outdoors to avoid 'Nature Deficit Disorder'. E. O. Wilson (1984) coined the term 'biophilia' to describe an 'innate sense of connection to the natural world'. The word 'innate' is contentious in ecology (Bateson and Gluckman, 2011) but it is used by Wilson to describe something which is present in all people from a very young age. Orr (1995) goes further to suggest that humans are born with an affinity for nature, similarly to Xuehua's (2004) assertion about Chinese children's predisposition to have affection for the environment. The purpose of emotional aspects of Environmental education is to nurture compassion for the environment, leading towards a stewardship role throughout life (Judson, 2010). Smith and Williams (1999:54) add the social context: "Environmental Education is about transforming relationships, establishing personal affinity, developing sense of place and experience of community".

The Conservationist/Resourcist current aims to change pupil behaviour and encourage small actions by individuals towards the wider goal of resource protection. Frequently, the main message is reduce, reuse and recycle. Activist NGOs involved in conservation frequently produce resources that share this current. There is a trend towards considering the economic value of natural resources; this happened for example in the 'Earth debates' at NHM, evening live webcast discussion events as part of Spring preparations for Rio +20 (Summer 2012). A personal reflection is that the importance of Game theory (benefits are dependent on the actions of others) is rarely acknowledged.

The Problem-Solving current starts teaching with a particular negative issue to address. There has been criticism of guilt-prompting narratives because they can disengage participants, so this current is becoming less common (Palmer, 1998).

The Systemic current aims to develop systems thinking, starting with observation of species, the units of an ecosystem. For example, Barker and Slingsby's progression framework (1997) acknowledges naming species as the starting point of developing understanding about ecosystem interdependence. The Systemic current arose in the 1960s, and I see a parallel with the development of thinking around technological networking at the time. Given that children are increasingly accustomed to networks, it would seem intuitive that they should find the systemic current increasingly accessible. Orr (1995) and Peacock (2004) agree with respect to the field of Ecological literacy; the interconnectedness of human actions and ecological impacts is key. The Scientific current situates the environment as a context for science, which brings together a problem-solving investigative approach and systems thinking. Comparison of the 1963 Report of the Study Group on Education and Field Biology *Science out of Doors* with Braund and Reiss' *Learning Science Outside the Classroom* (2004) shows development in pedagogy and a shift towards personal and social practice epistemologies in England. Tensions are around presentation of science within the environment as modernist facts or post-positivist theories (Korfiatis, 2005) when science is presented as part of environmental explorations.

Conversely, Bermudez and De Longhi (2008) focus on the presentation of the environment within school science and criticise a tendency by teachers to use didactic methods which are not optimal for environmental concept development.

The Humanist/Mesological current covers historical, cultural, political, economic and emotional aspects of place. Clearly there are some areas of overlap with other currents. Sobel's place-based education (2004; also derived from Dewey, early 1900s), which uses one location as a starting point for cross-curricular themes relevant to pupils, would fit here.

The Value-centred current emphasises morals, values and ethical obligations to the environment. Religious and indigenous approaches to environmental stewardship favour these aims, for example the Maori alternative taxonomy which outlines human responsibility to maintain species populations in New Zealand (Auckland Museum; personal observation 2011). Jickling (2003) and Stevenson (2007) describe the need to allow pupils to decide their own values based on becoming more aware of different viewpoints. Stevenson raises a problem: structured school settings are not often conducive to genuine reflection on personal position, because of a focus on assessment and conformity in behaviour. However, Monroe et al. (2009) found that assessment requirements were not a barrier to engaging with EE; examinations were contexts for improving student attainment in Florida in Project Learning Tree. It is not clear whether assessment in this case recognised a range of viewpoints as valid responses. Gruenewald et al. (2007) used Foucauldian analysis to demonstrate that the assimilation of environmental education into general education causes tension because of the importance of allowing values to be developed by pupils rather than imposed by teachers. They propose the Earth Charter as a solution, suggesting teaching pedagogies that allow children freedom to explore their own viewpoints based on evidence. In contrast, Scott and Oulton (1998) proposed a set of sustainability values for the curriculum, to be conveyed by INSET days. They argued that whilst balance and fairness are key, green values should be made clear by teachers and presented as favourable. The psychological premise is that people will attend to information that has a value (Judson, 2010); therefore, it is necessary to develop the perceived value of the environment for future messages to have relevance.

In terms of new approaches, Sauvé (2005) proposes Holistic, Bioregional, Praxis, Feminist, Ethnographic, Eco-education and Sustainable development as currents.
The Holistic current is essentially about seeing oneself in context, in a global society. The epistemology is about being part of the environment, exploring without labelling and expressing meaning in personal ways such as by using artistic approaches.

The Bioregional current almost emulates indigenous relationships with the environment, and focuses on using the local environment for resource production, for example planting, harvesting and selling organic produce.

The Praxis current involves action research, making changes and observing the outcomes, presumably over longer time periods than short-term scientific inquiries.
The Social critical current arises from Critical Theory in 1980s and looks at power relationships. It asks why the environment matters and to whom? Reflecting in 2007, Stevenson explained this term; pupils should ideally be able to learn about different viewpoints through inquiry and form their own opinions, which will determine their actions and behaviour. Therefore, an aim of the current Social critical model is for pupils to understand how a set of beliefs would translate into consistent actions towards their goals for the environment.

The Feminist current acknowledges that women are often the first environmental educators, showing children food and plants. It is unclear how this is translated into pedagogy, but a theoretical perspective in the field is concerned with characterising women's relationship with nature.

The Ethnographic current acknowledges multiplicity in views of the environment and science, explicitly valuing indigenous knowledge. These perspectives are often locally driven and highly specific. For example, in the Tanji Village museum in the Gambia, it is appropriate to present concurrent interpretation of specimens as the different views of nine local tribes (personal observation). There is a tension in terms of the relative authority of Western science. Cultural understanding is starting to be treated with respect by many as a part of Environmental Education (Dillon and Stevenson, 2011). Judson (2010), from Canada, explains examples of cultural involvement that focus on how best to integrate First Nation narratives; she gives a Hopi Indian example such as 'How Grandma Spider named the Stars' (Caducho and Bruchac, 1988). O'Donoghue and Lotz-Sisitka (2011) describe examples of how research has helped integrate cultural viewpoints in South Africa for Environmental education programme planning. The important role of Indigenous knowledge has gained prominence owing to curriculum reform in several countries, including South Africa (MJ Schwartz, UNIZUL educator, Eastern Cape and Lisa Combrink, Iziko Museums educator, Cape Town, in conversation Sept 2011).

The Eco education current suggests that environmental explorations can be significant life experiences that develop individuals' environmental understanding (Berry, 2003). Cottereau (1999) terms this Ecoformation, or eco-ontogenesis, which is similar to the stages previously discussed in Section 2.1, and the historical Nature study view that there are stages of development around environmental understanding (Von Wyss, 1913). Dowd (2009) considers that these significant life experiences are critical in outdoor science educators' career choices.

Finally, the Sustainable development current aims to develop ideas of equity in terms of production and consumption. Questions in this area focus on realistic sustainability, and the definitions and relationships of sustainable development, education for sustainable development and development education. The following perspective explains a tension, namely that sustainable development prioritises technical and economic progress, compared to other perspectives:

> The function of education in sustainable development is mainly to develop human capital and encourage technical progress, as well as fostering the cultural conditions favouring social and economic change. This is the key to creative and effective utilization of human potential and all forms of capital,

> ensuring rapid and more equitable economic growth while diminishing environmental impacts.
>
> (Albala-Bertrand, 1992:3)

This research starts with a perspective aligned to Stevenson and Stirling (2011), who acknowledge natural science and social science as components of environmental education. This Section has shown how the milieu surrounding environmental education has led to an increased emphasis on perspectives about understanding the role people play in shaping the environment. This research shares the view that well considered pedagogical observations were made by educators in the early twentieth century (although concepts of social research, learning and communication were very different to contemporary twenty first century views):

> It is necessary to dispel the illusion in the minds of some contemporary educators that environmental education is new; a product of our growing concern for the environment. On the contrary, the environmental education movement around the globe has evolved over many years.
>
> (Palmer, 1998:5)

2.2.2 Pedagogy

> The primary purpose of nature study was – and still is – to develop an understanding and appreciation of the natural environment through first-hand observations.
>
> (Stevenson, 2007:140)

Consultation of education providers for the IYB revealed recommendations for authentic learning. Educators surveyed in January 2010 for the purposes of this thesis recommended that learners have real experiences, with ‘real’ defined as outdoors, 3D or alive depending on whether they worked in environmental education, natural history settings or zoos. Likewise, Dillon and Stevenson (2010) suggest that best practice focuses learning on authentic situations. "Lack of an emotional connection is addressed by focusing learners on authentic activity around socially or ecologically significant problems" (2010:227). From my own experience as an Education Manager on the West London Floating Classroom, there is something magical about being outdoors in a new situation, certainly for the majority of primary children. Indeed, there is neuropsychological evidence to suggest that a certain level of novelty increases neural plasticity (Bateson and Gluckman, 2011), that is, the ability to form new brain cell connections which is the biological basis for learning. This evidence is therefore relevant to being outdoors in new spaces, which by definition involves novelty.

The Centre for Ecoliteracy (2008) translates a mixture of perspectives into pedagogy by explaining the activities that pupils will do for each strand. It states that effective Ecological Education programmes:

- Provide children with direct experiences with the natural world outside the classroom
- Focus on the cultural, historical and natural features of children's local community and region
- Are project-based and involve students in projects that make a difference in the local community
- Integrate in-class learning with hands-on experiences outside the school but also within the school (for example, participation in planning school activities, involvement in school lunch preparation)
- Nurture the psychological and physical health of the child by affording him/her opportunities to be/learn in nature
- Address cognitive, emotional, aesthetic and physical dimensions of learning.

(www.ecoliteracy.org, accessed June 2012)

This set of criteria from the Centre for Ecoliteracy, which is meant to apply to all school age pupils, does not include political understanding. Although Stevenson

(2007) considers it vital to empower pupils to drive change, there is no evidence about whether political ideas can be modified so as to be accessible for young primary children. Issues in environmental explorations pedagogy include whether it is necessary to record information, and the role of questioning by educators. This thesis is not focussing on educator characteristics at this stage; the lens focuses on pupils and their interaction with objects and environments. However, the wealth of research about educator professionalism, practice and identity is acknowledged.

In 1963 effective environmental exploration session quality indicators were: a spirit of inquiry; student initiative; accurate recording; a means to an end; and experimental confirmation of hypothesis (Report for the Field Studies Council, 1963). Braund and Reiss (2004) show how Bloom's taxonomy (1956) can be used as a basis for pedagogy when learning science outside the classroom, in cognitive, affective and psychomotor domains. The Cognitive domain includes the development of knowledge and intellectual skills, including data analysis and synthesis. Examples of science learning activities are observation and questioning, and applying knowledge to interpret results, as well as the practical necessity to understand safety considerations. Teaching strategies would facilitate pupils in researching and undertaking inquiry-based learning. The Affective domain covers pupil responses to events, and also how attitudes and values are developed. Examples are pupils expressing their feelings about a visit and about a theme such as conservation. Teaching strategies and questions would therefore be designed to make sure pupils got the opportunity to express and reflect on new viewpoints and emotions. The Psychomotor domain develops the ability to link sensory input to refined motor output, for example describing out-of-the-classroom learning using senses of touch and smell. In addition, measurement and gathering of data may involve psychomotor skills. Suitable teaching strategies provide opportunities to handle objects or touch living species such as plants, and questioning would encourage pupils to explore sensory aspects of the environment.

Falk and Dierking's (2000) contextual model of learning looks at three contexts: personal, sociocultural and physical. They suggest that engagement is most likely to result where the fields overlap. In the same way that understanding Bloom's taxonomy leads to planning learning activities, educators who agree with the contextual model of learning (shown in Figure 2.4) plan teaching strategies that will allow pupils to develop in the three contexts.

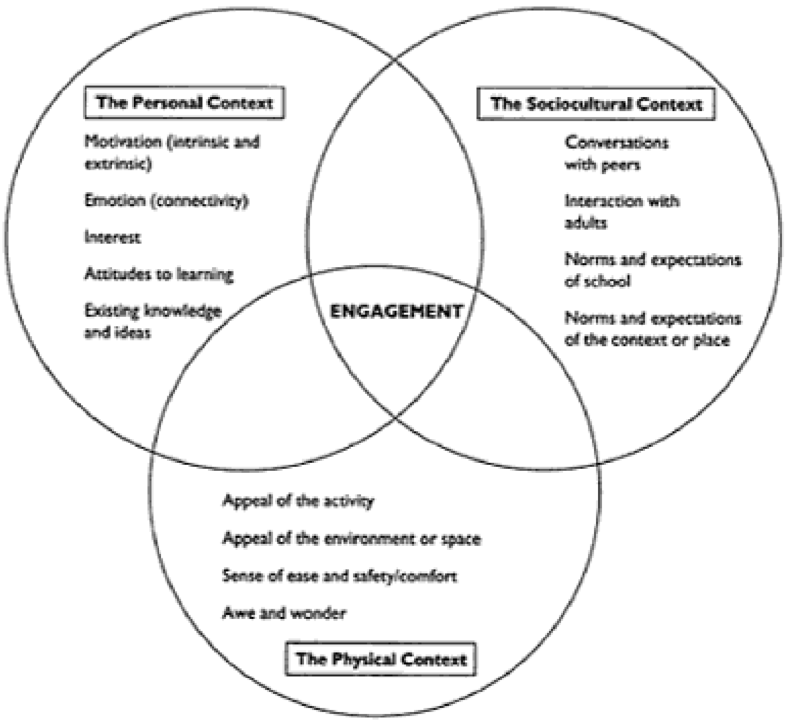


Figure 2.4 Contextual model of learning. Falk and Dierking (2000: 148)

Waite and Pratt (2011) propose a relational model and sees pedagogy as central and governed by national and local contexts as well as the child, others and place; Figure 2.5 illustrates their perspective.

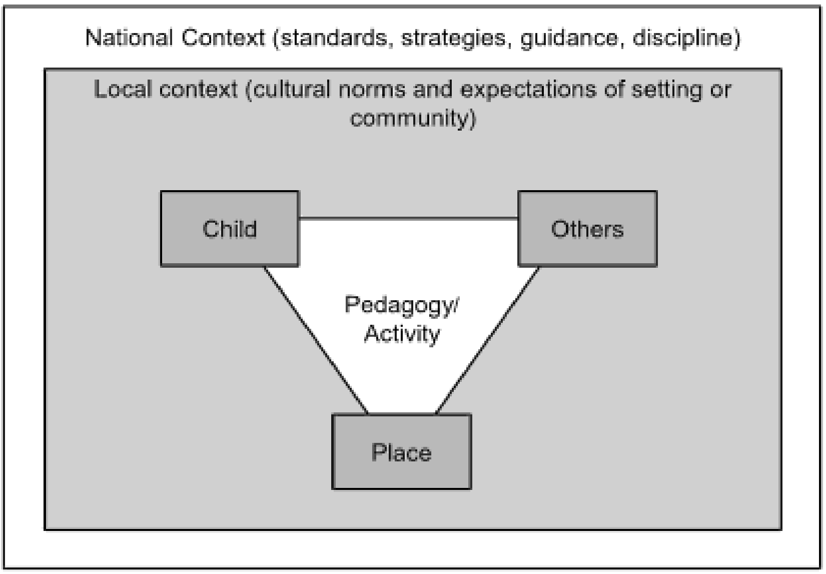


Figure 2.5 Pedagogy at the centre of contextual, personal, social and place factors (Waite and Pratt, 2011: 7)

The pedagogical model in Figure 2.5 is important because place is seen as an active component. This is a view subscribed to by this research, because the biotic and abiotic factors of environment settings are dynamic, and the extent to which surprising events take place must be factored into session structure and learning opprtunities. Waite and Pratt (2011) explain that the pedagogy of Forest schools focuses on strategies to maximise learning through repeat visits in this way. The implications of this model for this research are that it is essential for educators to have a thorough knowledge of place in order to structure learning in cognitive, affective and psychomotor domains.

Gompertz et al. (2011) suggest Earthwalks as a teaching strategy to maximise pupils' engagement and sense of belonging when investigating science out of doors, and propose a range of activities to focus attention and enable what Bixler et al. (2002) refer to as 'wider observation and more vivid recall'. They state a psychosocial perspective as the impetus for their work. Good practice in science education pedagogy includes pedagogies originally more common in humanities subjects (Osborne and Dillon, 2010). Likewise, Kelly and Cutting (2011) explain that drama and narrative can be used to extend understanding of the social aspects of the environment. Conversely, some historical perspectives from the UK show that non-scientific perspectives were not valued in environmental education. The Report of the Study Group on Education and Field Biology (1963:6) states “there is little educational value in taking groups of children to stare uncomprehendingly and unguided at nature, or to listen to sentimental, superficial discourses by people without scientific understanding”!

Dillon, Heimlich and Kelsey (2013), in the introduction to Chapter 5 of the *International Handbook of Environmental Education Research*, acknowledge that much research prior to Rickinson’s (2003) review of environmental education research focused on knowledge, attitudes and behaviour. They propose that this may be related to the fact that many researchers have an ecological science background, and they claim that this would lead to an instrumental view of the learning process, i.e., that understanding facts leads to a change in behaviour, action or attitude. Lundholm, Hopwood and Rickinson (2013) concluded that dealing with emotions and values, questioning relevance and negotiating viewpoints amongst students and teachers results in greater richness of the student learning experience.

More recently, the role of psychology and emotions in learning has started to become an area of greater research focus. For example, in 2012 the English Biodiversity annual conference ‘Communicate’, organised by the Bristol Natural History Consortium, featured a panel debate called ‘The Carnegie Challenge Debate: Head versus Heart – Changing Behaviour or Influencing Core Values?’ The session also included a workshop in the Psychology of partnership within biodiversity communication. More recently, in June 2014, King’s College London held a multi-disciplinary conference, ‘Learning Beyond the Classroom’, bringing together psychology researchers, education academics, museum professionals and teaching staff.

Jickling and Wals (2013) suggest that environmental education needs reinvigorated. An emergent field is that of *Environmental ethics or justice*. Jickling and Wals (2013:71) justify this approach as follows:

1. For environmental educators, research always involves normative questions, implicitly or explicitly. Whilst at the start of this research the normative element was implicit, I hope I have elucidated some of the normative practices in EE, NH and LA settings and therefore made some of this explicit.

2. Attention to normative ideas is underrepresented in our literature.

3. Tackling normative questions involves uncertainty and risk, and they can be inconvenient.

4. Key normative questions for education researchers concern ethics and education.

For example, considering normal practice for educators who use specimens involves considering how pupils view dead specimens, which is something which is a normative part of practice using natural history collections. Investigating children's viewpoints involves the risk that negative or uncomfortable views may be revealed.

Jickling and Wals (2013:71), in a series of questions that would prompt an identity crisis in even the most resilient of personalities, define the sort of ethical questions that should be addressed through environmental education:

- What is a good life?
- What is a good way to live?
- What should I do?
- How should I live?
- How should I live in the context of the larger good? (page 71)

These are compared with Canadian First nation approaches, giving an awareness of normative practices in Western values through engaging with life questions through indigenous values:

- What can we do to ennoble ourselves?
- What can we do so people will tell good stories when we are gone?
- How can we carry on our lives so that at the end we will have accomplished what the creator wanted for us? (p 72)

So, if environmental ethics focuses on the use of resources, then pedagogies for exploring ethical questions in this area could usefully be applied to children's questions about animals in captivity in live animal shows, and animal provenance and display in museums. It is clear that such issues are associated with post-colonial discourses (MacKenzie, 2009) and therefore the literature in these fields would be relevant in exploring the ethics of biodiversity teaching in a range of situations, in future research.

Olvitt (2013) supports the view that argues that new ways of engaging with the diversity and complexities of people-environment relationships are needed. This would position environmental ethics research in new, dynamic ways. I think this would also be to re-pitch Environment Education and counter claims that it has had its day. For example, the title of the book presenting the viewpoints above is *The International Handbook of Research in Environmental Education*. The title of the book in itself is quite notable; I was surprised to see it exist. I would have expected to have seen something like the *International Handbook of Research on Environmentally Sustainable Learning*.

There have been several attempts to reinvigorate environmental education, which has been associated with overly negative messages – for example the doom of impending flooding caused by climate change (Sanera and Shaw, 1996). Some people consider that Education for Sustainable Development (using societal needs as a driver for education, Robottom and Stevenson, 2013) and biodiversity education are simply semantic attempts to reinvigorate environmental education, marking evolution of content, using new titles to signify to the outside world that the topic is dynamic. The aspects which children learnt in the informal biodiversity sessions in this research could be used as a point for reflection for educators; do children learn what educators intend? How do these aspects relate to current environmental approaches?

This Section has demonstrated a range of currents that underlie the purposes of, and trends in, teaching about biodiversity through environmental exploration outdoors. Informal learning pedagogies have shifted from being largely observation, then incorporating inquiry and now encompass a wide range of teaching strategies that reflect multiplicity in purpose. The next Section will look at the literature about live animal shows in education.

2.3 Education with live animals

Research about zoo education is relevant to live animal shows. These shows tend to take the format of "varying between fact giving and question answering with different outcomes for each session" (p56), referring to Animals in Action at London Zoo (Visscher et al. 2009).

2.3.1 Aims of education with live animals

Figure 2.6, from 'New Worlds, New Animals' (Hoage and Deiss, 1996), provides an overview of the parallel development of zoos and natural history collections (as well as botanical gardens and aquaria, which are outside the scope of this study) in the eighteenth and nineteenth centuries. Zoos and natural history collections share common themes regarding zoology, taxonomy, provenance of species and links with colonialism. Figure 2.6 is relevant to this thesis because, in comparing education using specimen collections and live animals, it could reasonably be expected that there would be similarities in approach when the fields developed at similar times.

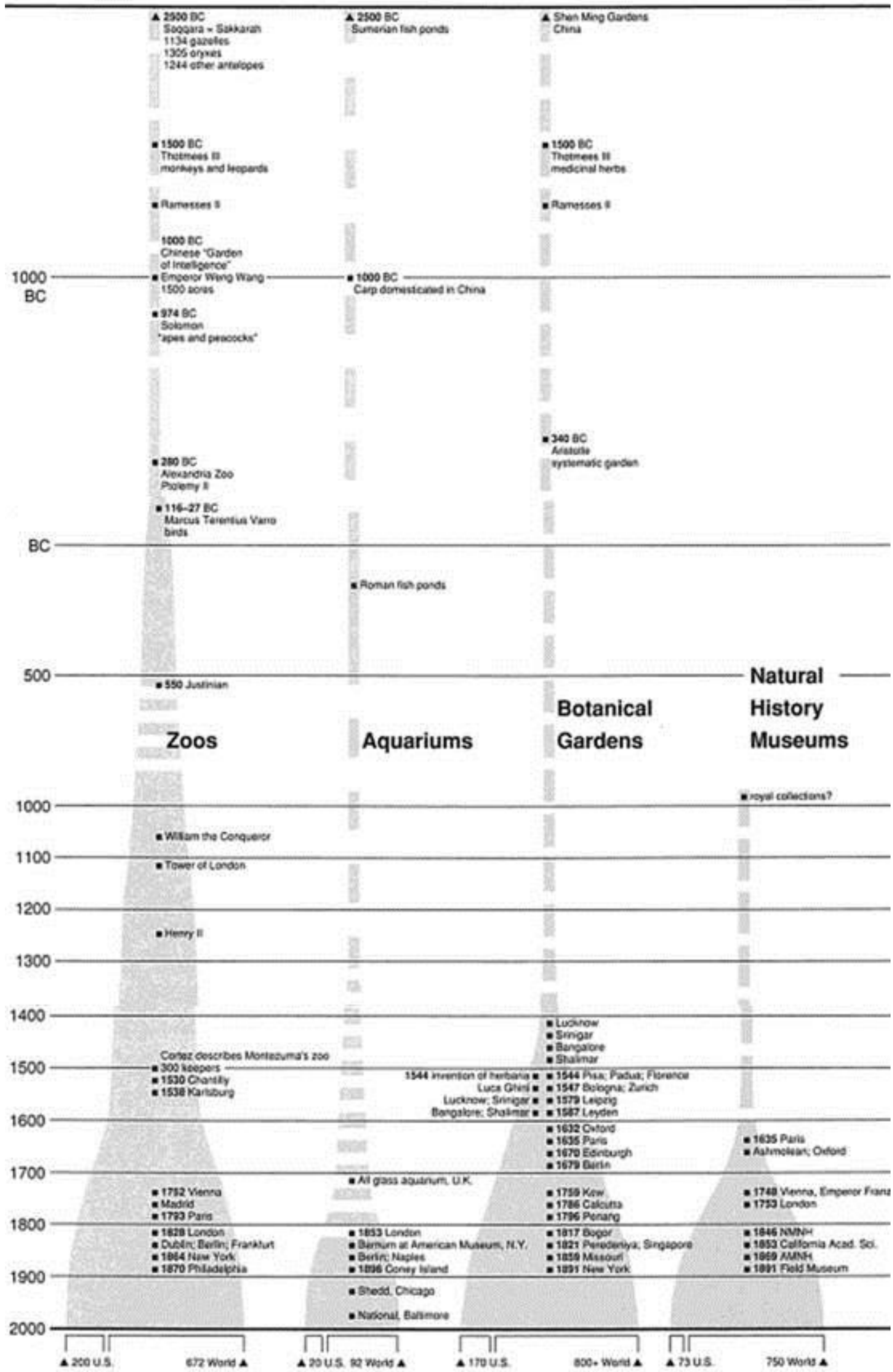


Figure 2.6 The parallel development of zoos, botanic gardens, museums and aquaria (Hoage and Deiss, 1996: IX)

Informal science education through meeting living animals has historic roots in the 1900s, when the zoos began to open education departments (for example, London Zoo and the Bronx Zoo). It is important to acknowledge that there are viewpoints opposing animals in zoos (Kiley-Worthington, 1990), and there is a distinction between organisations that prioritise profits from charismatic megafauna (Baratay and Hardouin-Fugier, 2004) and those that prioritise long term species preservation. Baratay and Hardouin-Fugier document the changes in approach from a romantic view of the wilderness presented in the late eighteenth century, which gave way to a respect for nature and connection to nature. They cite popular literature of the 1900s as being influential in attitudes to nature, for example tracing themes from Jack London's *White Fang* (1906) to Disney films and popular culture tales which frequently anthropomorphise animals. They relate the expansion in popularity of zoos to expansion of the leisure industry and economic growth.

Children have been an important audience for zoos since these organisations were established. London Zoo archives hold a book called *Henry and Emma's Visit to the Zoological Gardens* which is from 1829! Baratay and Hardouin-Fugier (2003:207) state "children's attention at zoos is most focused between the ages of 4 and 10", and go on to suggest that at this age children 'project their own imaginary bestiaries onto the animals they see, who thus serve as illustrations of a sort of virtual reality' (2003:208).

Although the source of their data is not clear, the describe aspects which children are interested in:

- Morphology (children comment on the trunk, neck and hump, which they identify through prior experience)
- Names (they may give them names if they are unsure)
- Family relationships.

According to these authors, four to six year olds often speak to the animals, and prefer animals that look like soft toys. Older children are more likely to choose animals that relate to popular culture, literature or film. Critics see this as evidence that zoos are projecting an extension of adults' anthropomorphism of animal behaviour, for marketing purposes.

However, there is a high level of literacy about the philosophy of animal display within zoos and, for example, the organisation BIAZA (the British and Irish Association of Zoos and Aquaria) has strict standards for members about inclusion which stipulate animal welfare, conservation and education as central to their goals. The Universal Declaration of Animal Rights (UNESCO, 1978) led to review of animal captivity conditions, and this can be mapped against an increase in the number of safari parks versus zoos, spaces where animals were given some space to roam. In the UK, the Zoo licensing Act (1981) limited the ways which animals could arrive at zoos, and this was another landmark in animal provenance standards.

BIAZA is a sub-group of the European Association of Zoos and Aquaria, which sits under the World Association of Zoos and Aquaria. Members share information about the genetic complement of species they own, in order to plan breeding combinations which will widen the gene pool, with the aim of increasing species genetic diversity to confer resilience in the face of future environmental change. Zoo visitors are encouraged to appreciate the scientific endeavour undertaken by zoological organisations.

2.3.2 Use of animals in education

Issues in zoo education include animal welfare and the relationship between conservation and marketing goals. For example, live animal shows do not wish to be associated with circus shows which often train animals to carry out human behaviours for entertainment (as early as 1925, a law was passed in the UK to protect circus animals). In contrast to circuses, a live animal show at a reputable zoo should demonstrate natural behaviours. Although this may seem a subtle difference to an outsider, it is of critical importance to educators working in the field. There have been various trends during 1900 about animal presentation, for example whether predators are presented as fearful or gentle, but mis-representation or exaggeration of traits to elicit visitor response is seen to align more closely with marketing goals and is not supported from an education perspective. Michael Robinson, Director of the National Zoological Park at the Smithsonian Institution in Washington, US, states 'exhibits will provide zoo visitors with a realistic view of how life forms and habitats are truly inter-related on this planet' (Hoage and Deiss, 1996:XI).

According to Baratay and Hardouin Fugier (2003:31), "the four functions of recreation, research, conservation and education … form the central credo in the justification of zoos which is well-received by the public". Education has increasingly become a central objective for zoos (Patrick and Tunnicliffe, 2013) as the importance of spreading the conservation message has increased in profile. As long ago as the mid-1900s Regent's Park Zoo, Whipsnade Wild Animal Park (now combined as the Zoological Society of London) and Paignton Zoo were offering courses such as the biology, movement, diet and social behaviour of primates and felines.

In 1993 E. O. Wilson stated that zoos must educate, argue and explain. In common with environmental education, increasing urbanisation is frequently cited as a key reason why children should encounter living animals (Patrick and Tunnicliffe, 2013). Urbanisation is of particular relevance to this study given that research is taking place in an urban setting in central London. The Society for Conservation Biology has set out the principles, concepts, goals and values of conservation literacy (Trombulak et al., 2004). One key idea in biology conservation education is that the living world is of personal worth to the learner. This is seen to be critical in order for children to take future positive actions towards conserving natural environments (Patrick and Tunnicliffe, 2013); natural history education settings have a responsibility to promote the preservation of global diversity (Buffon Symposium, 2007). The extent to which this is based on research, animal management and communication activities varies between organisations.

However, it is now widely acknowledged that visitor behaviour change as a result of encountering live animals is a legitimate and important outcome of a zoo visit, and one that zoo educators should plan for.

McManus (1987) found that “Children may talk to the animals” (p265). Miles and Tout (1992:32) state that “Living animals that are more dynamic elicit more diverse and long-lasting conversations”. Figure 6.11 shows Miles and Tout’s classification of exhibits in which “the animal becomes the educational tool” (Patrick and Tunnicliffe, 2013:62).

Static exhibits				**Dynamic exhibits**							
Physically passive: watch, listen, smell		Physically active- touch manipulate		Physically passive: watch, listen, smell				Physically active- touch manipulate			
Models	Preserved	Models	Preserved	Live	Constructed			Live	Constructed		
					Passive	Active			Passive	Active	
						Predicatble outcomes	Unpredicatable outcomes		Opportunistic development	Predictable outcomes	Unpredicatable outcomes
A few specimens in a museum	Most specimens in a museum	Statues in zoos. Some may be part of exhibits as an accessory like footprint casts	Some specimens found in a discovery corner	Most live specimens	Automatic models such as animated dinosaurs	Visitor can choose not to be actively involved	Watches others	A few opportunities in children's zoos at animal encounters		Push buttons or turn handles	Visitor is involved and may use computer programs

Figure 2.7 Visitor Participation types at animal exhibits (Miles and Tout, 1992)

Using this model, the live animal shows which were tested alternate between being dynamic exhibits where the children are physically passive and those where they are physically active (due to volunteering opportunities). The sessions being investigated were the typical booked educator-led ‘sessions’; therefore, the live animal show did not offer as many opportunities for children to discuss what they were seeing as the museum and environment centre (the latter two involved exploration time as part of the educator-led session). Should live animal shows include more time for children to engage in conversations during the show, in order to cement learning, for example using ‘talk partners’ as in classroom teaching? This could be an example where an informal learning setting could helpfully borrow pedagogy from formal learning. Talk is beneficial for learning in classroom teaching (Noon, 2007), particularly for pupils who do not speak English as their first language (DfES, 2003).

Conversations in informal learning have been the subject of research. Patrick and Tunnicliffe (2013) provide insights into the function and form of conversations about biodiversity within visitor groups at zoos. In function, conversations "represent the thoughts and experiences of the discussants" (2013:92); some utterances have the purpose of linking new stimuli that the observer has seen with prior experience. Halliday (1980) calls this experiential talk, based on observations and noting facts. Patrick and Tunnicliffe (2013: 95) found three levels of labelling conversations that take place in zoos. Level 1 tends to occur between adults and babies/toddlers. The adult draws attention to an animal's name, repeats the name, and encourages the child to do the same. When they do, the adult rewards the child with praise. It can be thought of as an Adult-Child-Adult interaction, in that the adult both initiates and closes the conversation. Level 2 is found between adults and pre-school children. It includes names, naming, labelling plus some description. Similarly to level 1, the adult points out something, the child responds and the adult adds some details before closing the conversation. Level 3 is found with school-age children, and involves the child initiating the conversation. The adult then verifies their comment in some way, and the child, in turn, reacts to what the adult has said.

This research aims to understand how these perspectives influence what children learn about habitats and adaptation when they encounter live animals.

2.4 Museum education using natural specimens

2.4.1 Aims of museums

According to the International Commission on Museum's (ICOM) Statutes, adopted during the 21st General Conference in Vienna, Austria, in 2007:

> A museum is a non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches,

> communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment.
> (http://icom.museum/who-we-are/the-vision/museum-definition.html Nov 2011)

How does this translate to school workshops with collections? In 1954 Jacqueline Palmer, Teacher at London's Natural History Museum, wrote that museums had three purposes:

> The chief one is to preserve their collections, the second to see the collections are properly classified and described. The third is to put out objects on show to encourage visitors to enjoy the collections whether for study or recreation.
> (Palmer, 1954:12)

The comparatively low priority given to education, in Palmer's estimation, hints at a tension that is well documented in museum research (see, for example, Falk et al., 2011; Hein, 1998; Hooper-Greenhill, 1991a). The purpose of museums has oscillated through history between collection, preservation and research and public education through history.

2.4.2 Use of natural history specimens in education

MacKenzie (2009) describes Natural History collections as being like a 'Tardis' for travelling in time and space by encountering historical objects and specimens from around the world. Today, the intervention of technology has allowed specimens to distance themselves from their colonial past and assume a distinctive personality and character in the public eye, for example, the cheeky giraffe at Dublin Natural History Museum who tweets about visitor fashions. This means that a new narrative about the specimen would be memorable to the public, rather than the story about how the specimen came to be in the collection. Handling collections are also found at zoos and veterinary colleges. Such specimens are also known as biofacts;

sometimes specimens are seized by airport customs officers (when they are illegal goods) and donated to help conservation education:

> The more I looked at them, the more I studied them, the more I appreciated their beauty over and above the information about their context. They were beautiful! The more I described them and handled them, the more emotionally attached to them I became … My eyes opened.
>
> (Dr Ekpo Eyo in Vogel 1991:5, quoted in Dudley, 2010)

Dr Eyo's quotation illustrates the aura of the object that is at the centre of learning from collections. Key words in museum education are participation (Simon, 2010) and engagement (Black, 2005) – similarly to informal science communication described at the start of Section 2.1. Moving away from a modernist authoritarian approach to knowledge, many viewpoints and two-way dialogue with visitors are now widely seen as best practice.

This Section will focus on the use of natural history specimens for informal science teaching about habitats and adaptations, in order to better understand the benefits for pupils who participate in specimen handling sessions. A natural history specimen collection is defined for the purposes of this study as a collection of natural objects mainly in the field of zoology or botany, and on occasion palaeontology. A handling session can take place in a museum or university setting, facilitated by teachers or informal science educators, and can vary in duration. Natural history handling collections have different aims depending on their genesis, academic links and degree of educational purpose. The Museums, Libraries and Archives (MLA) Council developed a framework called the Generic Learning Outcomes (GLOs) for museums which can be used to analyse purpose at the outset of programme development. It covers the domains of: knowledge and understanding; enjoyment, inspiration and creativity; skills, activity, behaviour and progression; and attitudes and values. It has been widely used in museums, and will be the analysis framework for the pilot study presented in Chapter 3.

There is a continuum between collection-driven and audience-led public activity, which is a feature of natural history collections that does not directly translate to environmental explorations. For example, museum 2.0 is a phrase used to explain the way that the relationship between museums and their audience is two-way, like web 2.0.

The unique aspect of natural history specimens is the physicality of specimens: three-dimensionality, weight, texture, surface, temperature, smell, taste and spatio-temporal presence (Dudley, 2010: 6). How can educators maximise benefit for learners in facilitating interactions around objects? Object lessons were popular in the late nineteenth century as methods to learn about nature. Manuals of object lessons were printed for teachers to use, similar to the way lesson plans are shared online in 2012. How has learning from objects been reframed over the last hundred years? Sayre and Wetterlund (2008) surveyed 85 museums, finding the following formats: Tour programs; Informal Gallery learning programs; Community, adults and family programs; Classes and other public programs; Partnerships with other organisations; School workshop programs; and Online educational programs. In addition, experience and surveying education providers has shown that festivals, universities and city agencies, videoconferences and curating with students are examples of learning activities around collections. Much of the research written about specimen handling has been set in the context of school workshop education. The English school Inspector E. Wastnedge highlighted the potential of museums for schools in 1972:

> The enclosing classroom is becoming obsolete; the scope of the school has widened beyond its walls. Children develop in a broader environment; the surrounding world serves their schooling. Children of all ages are encouraged to explore, to make choices that are personal and have meaning. What better than the museum with its great diversity of objects to provide stimulus for their activities?
>
> (1972: 10)

The physical properties of objects are mediated and made relevant and personal through context and social interaction, using Falk and Dierking's (2000) contextual model of learning. Dierking (2002) argues that object-based learning fits the contextual model because it is important to acknowledge the spatial and temporal context in which object learning takes place. The implication of this for the educator is to consider what children will see before, during and after their visit, features that the educator may classify as everyday background. Kisiel (2006b) discusses pre- and post-visit materials for natural history visits. Paris and Hapgood (2002) note the potential for researching children's development in informal learning environments, questioning why there is a paucity of research. Like Dierking, they share the view that surrounding narrative is a key element of object-based epistemology. Paris and Hapgood (2002) also suggest that the way in which objects are viewed depends on intrinsic curiosity, integration with technology, family conversations and museum literacy (meaning familiarity with typical museum conventions).

There is evidence that the role of experts has been increasingly acknowledged in collection-based education, although some of the clearest statements are from around 1970, around the time educational technology was emerging as a field; for example Roger Miles' (Silverstone et al., 1994) work at the Natural History Museum. Wastnedge encapsulates a view from this time:

> Physical contact is absolutely essential … before the full mental impact of 'real' things can be released, museums have a very significant, and very exciting, part to play in this particular sphere of education. The authenticity of the genuine article backed by the expertise of museum staff can vividly bring to life appropriate parts of the curriculum, create the keenest interest, and stimulate the mind and imagination to a far greater extent than other visual aids on film which are in comparison second-hand.
>
> (Wastnedge, 1972:32)

Current discussion (Dudley, 2010) proposes that sensory and cognitive engagements with objects are mediated through the materiality, perceptual and ontological qualities of objects themselves. In addition, museum contexts develop affective (defined as sensory plus emotional) responses and wellbeing. Good examples are creative, innovative, artistic museum practices that seek to illuminate or critique museum objects or interpretations. Practical writings and reflections from the 1950s and '60s such as museum educators Marcouse (Victoria and Albert Museum, 1961) and Palmer (NHM, 1954) focus on visual, haptic, oral, aural, gustatory and kinaesthetic engagements. Early writing in *The Listening Eye* (Marcouse, 1961) could be interpreted within today's neuroscientific approaches as attentional spotlight theory (Pearce, 2010). There is a role for neuroscience in understanding learning; no doubt there is a neural mechanism by which affective responses could be correlated with touch responses. Using Gardner's Multiple Intelligences (2003), bodily, linguistic, intrapersonal, interpersonal and kinaesthetic intelligences are used in handling objects.

The need to record information is contentious. Price and Hein (2002) surveyed five natural history settings and concluded that successful sessions involved structure with flexibility, were not in a school setting, had a variety of activities, included no worksheets and practised first-hand experience followed by teacher talk and open questioning. The Institute for Learning Innovation (Falk, 2011:329) recommends the following for museum learning experiences: 1. Allow for the Individual's own unique learning agenda to emerge; 2. Address the effect of time on learning; 3. Respect that learning is always situated and contextualised; 4. Be open to a broad range of learning; 5. Emphasise validity over reliability. With the caveats of structured workshops and with school groups, the educator should aim to set up these conditions as far as possible.

Griffin (1998) recommends that students understand why they are visiting a museum, know what they are there to learn about, have choice in the specifics of their learning, and are able to learn and to record information in ways that they prefer. Susan Groundwater-Smith and Lynda Kelly (2003) in Sydney asked upper primary and secondary students to photograph examples of aspects of the museum that help or hinder their learning. Students then developed posters of their findings.

They revealed four categories that helped learning: (1) Cognitive – when they know how things work, have opportunities to ask questions, seek information from varied sources, and are stimulated through various senses; (2) Physical – when they are safe and comfortable, able to move easily, the space is well lit, and the scale is appropriate; (3) Social – when learning with friends, a satisfying social occasion; (4) Emotional – when connected to their interests but not when emotionally confronted. Rennie and McClafferty (2001) found that young children in science centres learn more when given the opportunity to interact with peers and adults. Griffin (1998) developed a framework, School Museum Integrated Learning Experiences for Students (SMILES), to provide teachers with a process that prepares the students for their visit and makes school excursions operate more like family visits. It is based on three major elements: Purpose (students know exactly why they are going to the museum because the visit is part of a classroom-based topic); Choice (which specific parts of the museum will be visited and how students will find and gather information); and Ownership (of their own or their group's learning agenda). The students' and teachers' declared outcomes of both learning and enjoyment when the school field trips are run in this way clearly suggests the validity of the process. The preparation allows for meaningful interactions with the museum educators and the exhibitions.

Diesler-Seno and Reader (1991) describe a case study of positively transforming a natural history education programme at Corpus Christi Museum in the United States of America in response to declining child visitor Figures. They moved away from large audiences with little opportunity for discussion towards a variety of small group activities (local species classification, shore bird adaptation, predators and prey selections) where pupils could observe specimens and draw conclusions for themselves. These were then supported with key vocabulary (e.g. herbivore, carnivore, omnivore). The implications for teaching strategies are that educators need to plan the story around objects, handling, comparing, questioning about colour, texture and other descriptive factors, and the opportunities for children to voice their own stories and personal preferences around objects, and the surrounding context in order to facilitate meaningful learning.

One key aspect of this research will therefore be identifying whether there are differences in learning when children have access to authentic objects as a means to learning about biodiversity.

Reviewing the literature has informed the conceptual framework from which this thesis is approached. Drawing on museum literature as a basis, the initial framework for analysing learning is the Musuems, Libraries and Archives' 'Generic Learning Outcomes' framework (MLA, 2004), including the domains of learning Enjoyment, Inspiration and Creativity; Attitudes and Values; Skills; Knowledge, and Activity, Behaviour and Progression. Chapter 3 will go on to describe how this analysis framework, which initially seemed to allow scope to record a full range of learning behaviours, was found not to include enough consideration of socio-environmental learning, following a Pilot study. Conclusions from the pilot study allowed the development of a conceptual framework specific to this thesis. It draws in aspects from Nichols and Zeidler's socioecological literacy framework Earth Smarts (2012), and includes consideration of the importance of both the importance of place, and community skills, and will be further explained in Chapter 3.

2.5 Literature review summary

This literature review has shown that the current National Curriculum in England is subject-based in comparison to more cross-curricular Scottish and Northern Irish approaches. In England, learning how plants and animals are adapted to their habitats is covered in formal Science Education, for upper primary pupils. This knowledge is a basis for understanding ecosystems, which are thought to be an essential foundation for thinking about sustainability and natural resource use. Informal learning opportunities extend and enrich learning about habitats and adaptation, in more authentic contexts than are usual in a classroom. Research has shown that formal and informal learning experiences, as well as home experiences and the media, contribute to children's conceptions about living things. Pedagogy around natural history specimen handling activities has developed during the twentieth century, from initial interpretation of nineteenth century collections to object-based discourses of the twenty-first century. Discourses around environment exploration vary: at one end of the spectrum the purpose is seen to be facilitating outdoor learning about scientific enquiry; at the other, purposes include developing affective connections with the environment and appreciating human responsibility towards wild spaces and their inhabitants. Exploring safe novel environments is important for city children to develop the capacity for creativity. Ultimately, learning involves forming new neural connections, and being in new spaces may increase the likelihood of new pathways forming.

This thesis takes an approach between a disciplinary and personal epistemology of learning in asking the question: *What do children learn about biodiversity in informal learning settings?* The research aims to explore the potential of three experiences – environmental exploration, live animal shows and natural history specimen handling – for enriching pupils' learning about species adaptations and habitats. Chapter 3 will describe how a pilot study was used to develop a robust conceptual framework to inform data collection, analysis and review.

Chapter 3 Methods

This chapter provides a description of and explanation for the study's research design, shown in Figure 3.1. It explains the rationale and focus of the thesis, the paradigms it draws upon, and the methodology within which the methods sit. It discusses the ethical challenges that arose when designing and conducting this research, how the key question has been investigated, and indicates limitations of this research. Choices about methodology have been influenced by researchers in environmental education, museum education and live animal shows. Chapter 3 explained how initial methods were used at the Natural History Museum as a pilot study. This chapter uses modified methods which have been amended following reflection on pilot study results.

Phase I: February 2012 Phase II: April 2012

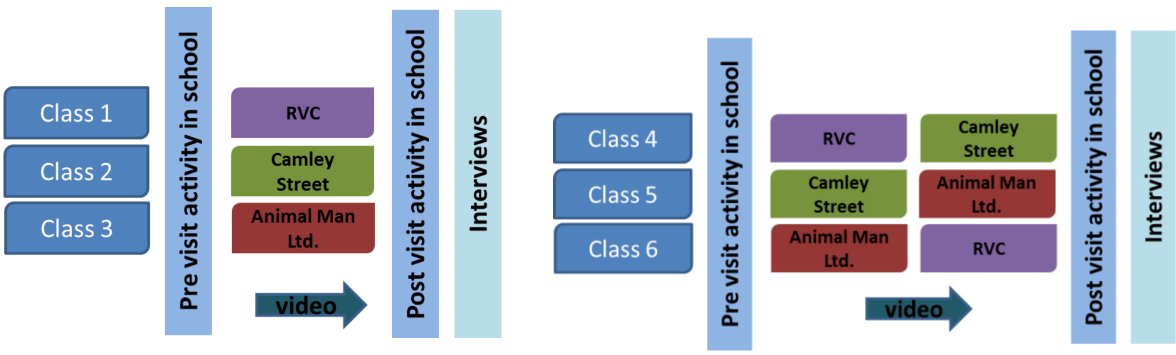


Figure 3.1 Research design overview, showing that six classes (Year 4 pupils) took part in informal biodiversity education experiences for the main data collection

3.1 Rationale – Research focus and questions

The literature review considered the educational theory around three different types of biodiversity informal learning experience. This thesis examines complementary learning that may take place in museum, environment or live animal experiences. It addresses questions about the learning that takes place in each setting. The main hypothesis of this research is that each type of setting conveys different messages to pupils, despite addressing the same curriculum links about habitats and adaptation. Therefore, the following research question is proposed:

> *What do children learn from taking part in a session in the following informal biodiversity settings, either singly or in pairs:*
>
> *A. An environment centre?*
>
> *B. A live animal show?*
>
> *C. A specimen collection?*

This question will involve considering the distinctive and common aspects of each setting.

3.2 Paradigmatical standpoint

This thesis uses social science research paradigms (sets of beliefs) as a basis for designing data collection and interpreting results. Social science research paradigms are in turn informed by their ontology (what is known) and epistemology (how it is known) – Lincoln and Guba (2000). This research comes from a critical standpoint, which means that it is differentiated from both positivist and post-positivist objective paradigms, and the subjective approaches of constructivism and participation, as defined by Toma (2011). To explain this further, my viewpoint for this research aligns most closely with critical theorist perspectives.

3.3 Critical Theory

Critical Theory assumes a degree of subjectivity rather than the existence of objective truth (Suter, 2012). Critical theorists acknowledge the importance of historical contextual factors, for example social, economic and cultural ones. In order to understand Critical Theory, it is helpful to know that the term 'Critical Theory' refers to a school of thought arising from the work of a group of theorists, the Frankfurt Group, who were active in the 1930s. They agreed with Marxist theories in general, but were critical of excessive narrowness. They drew on Freudian and cultural theories for alternative approaches. The most well-known members of this group in the field of education are Bourdieu and Friere. Offshoots of critical literacy are critical literacy (for example, see De Souza and Andreotti), critical race theory (Mirza and Joseph, 2009) and critical pedagogy (Darder, Baltodaro and Torres, 2009). Critical Theory acknowledges the importance of perspectival approaches, meaning that the way knowledge is viewed (epistemology) is seen from a particular stance such as feminism, anti-racism or post-colonialism. These apparent categories are actually fluid and subject to change and blurring boundaries. However, the underlying ideas remain constant: that gender, race, ethnicity, sexuality and geopolitics influence a given person's world view and agency (ability to effect change).

There are two main areas of debate regarding Critical Theory and epistemology: politics and the nature of knowledge. Political debates consider the contexts in which accepted knowledge assumes status and acceptance (Griffiths, 1998). The nature of knowledge is a subject of much academic educational debate. For example, Aristotle identified *praxis* (practical), *techne* (technical) and *episteme* (contemplative) types of knowledge. The post-modern theorist Lyotard explains a difference between measurable knowledge and knowledge of affective features such as ethics, people's characters and narratives (1984). This is significant for my research as, in attempting to group evidence for the learning for which I hope to see evidence, I will be drawing on an understanding of types of knowledge. Because I am familiar with using the MLA 'Inspiring Learning for All' evaluation framework (RCMG, 2004) I will be using the term 'domains' to describe the boundaries of types of learning. However, in contrast to an approach which uses a framework for evaluation alone (i.e. evidence of presence or absence of preconceived outcomes) I will be using the domains for research. I started by using the domains of enjoyment, knowledge, skills, values and activity, from the MLA framework (2004). I am now moving to using domains of place, skills, knowledge and attitudes, inspired by a socioecological literacy framework 'Earth Smarts' (Nichols and Zeidler, 2012). This will be discussed further in the analysis Section.

There is no one research method which aligns closely with Critical Theory (Griffiths, 1998). Instead, the choice, intention and use of the methods are crucial. Figure 3.2 was drawn by myself after reading Kelly et al. (2012); it is also shown in Section 1.3.

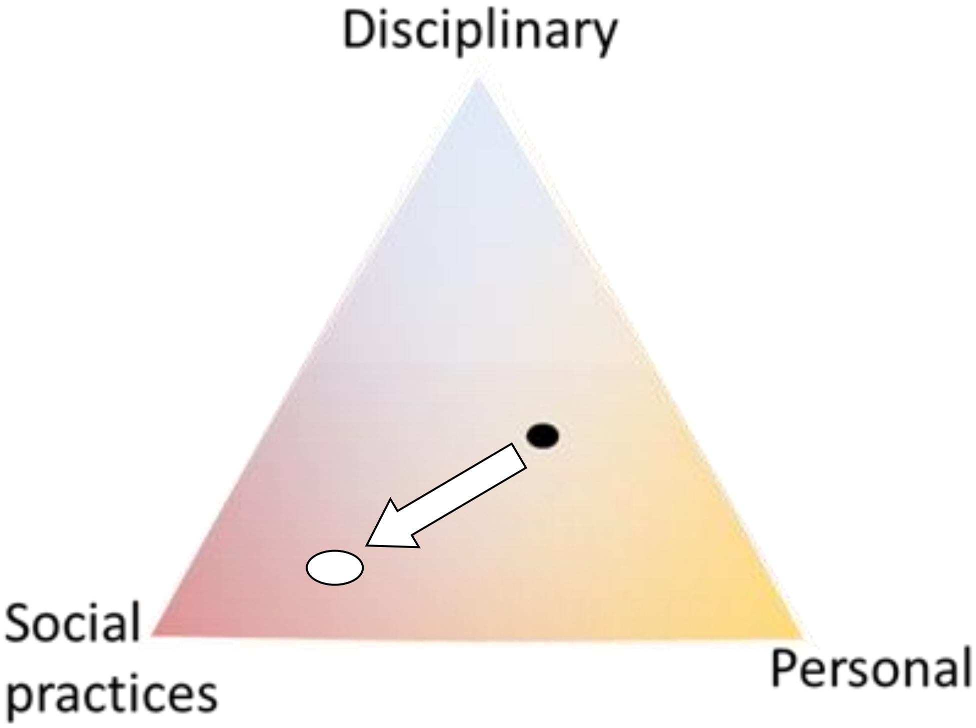


Figure 3.2 Epistemology of learning— drawn after reading Kelly et al. (2012). This shows how my perspective changed following the pilot study; the white arrow demonstrates shift towards social practices.

Introduced in Section 1.2, Figure 3.2 illustrates three ways of looking at knowledge acquisition, ranging from a more historic view of knowledge as exclusively factual (apex of triangle), to the view that transformation is personal for learners (right hand side) or the view that meanings are socially constructed (left hand side). Referring back to the pilot study and literature review, I started with a perspective close to the black dot shown in Figure 3.2. However, my perspective changed towards the left hand lower corner; I now appreciate the importance of the social construction of meaning more than before, as shown by the white arrow in Figure 3.2, based on the pilot study. This is explained more fully in Section 3.6. Therefore, the methods I have chosen will enable me to obtain data to answer the research questions, taking into account these different views of knowledge.

Data collection will involve pre- and post-visit activities to cover the domains of knowledge (factual), and knowledge of place, and ask children about their values. Video evidence is used to gather evidence about social interaction, values and skills. Interviews are intended to allow understanding of personal transformations, particularly in the domain of values.

This research will aim to understand the learning that takes place for pupils by grouping learning responses according to the informal biodiversity settings the pupils have experienced. Mixed methods, involving both qualitative small sample interviews and video and quantitative pre and post-visit activities with larger sample sizes, will be used, in order to triangulate the study and address issues of validity and reliability. Since the timescale and scope of this study permit research with one example of each type of setting, I acknowledge that caution will need to be exercised in extrapolating the results to similar situations. However, in keeping with the critical theorist perspective (Suter, 2012), I intend the results to stimulate action towards societal ideals, in this case relating to environment and personal agency. I aim that this will be achieved by using the results to prompt reflection and action by informal educators, leading towards informal biodiversity education programmes that are closely aligned with dynamically changing biodiversity issues. These programmes in turn should have the potential to prompt positive action from pupils.

3.4 Justification of approach

The questions in this research study will be answered using mixed methods. Mixed methods are increasingly used in educational research to provide better understanding of a research problem than when only quantitative or qualitative or other solitary methods are used (Creswell, 2011). Dillon and Wals (2006) describe the issues in post-positivist pluralist approaches with specific reference to environmental education research. They demonstrate that a range of approaches and vantage points exist within recent research, and agree with Hart (2000) that generic guidelines about how to research in environmental education should be considered with caution. Connell (1997) notes the proliferation of multiparadigm research, and urges clear understanding of ontology and epistemology. Rather than taking a pragmatic approach (Johnson and Onwuegbuzie, 2004), my choice of research methods was made from the perspective of Critical Theory. However, as Griffiths (1998) acknowledges, there is no one method that is generally applicable, and instead a range of approaches are suitable. Focussing on the research questions, and drawing on reading in the field of education research, I selected methods that would allow data collection for both breadth and depth in understanding the range of learning taking place.

In order to address issues of validity and reliability, triangulation of methods is sought by measuring learning in three ways:

1. Pre- and post-visit activities undertaken by classes of pupils in school
2. Video recording of informal biodiversity sessions
3. Interviews with pupils following informal sessions.

A literature review of EE evaluation studies (Carleton-Hug and Hug, 2010) concluded that new methodologies were needed beyond pre- and post-test intervention studies and summative evaluation. With this call for greater theory-building and methodological diversity, researchers have been orienting more strongly to learning in EE (e.g. Falk and Heimlich, 2009; Reid and Scott, 2013). This thesis also aims to advance EE through a focus on video-based methods to study learning processes (not exclusively outcomes) at a nature centre.

3.5 Research design

The research methods employed in this thesis have both quantitative breadth (reasonably large sample sizes surveyed using pre and post-visit surveys and qualitative depth (video and interviews). Figure 3.3 shows the specific sessions undertaken by each class.

	Day	Royal Vet College specimen handling	Camley Street Habitat exploration	Live animal experience
Single sessions	1	NH		
	2		EE	
	3			LA
Combined sessions	4	NH	EE	
	5		EE	LA
	6	NH		LA

Figure 3.3 Informal biodiversity sessions in which each of six classes took part. Single sessions lasted approximately one hour. Combined sessions lasted approximately two hours. EE = environment exploration; LA = live animal show; NH = natural history collection

Days 1, 2 and 3 took place consecutively, during Tuesday to Thursday in a week in Spring 2012, allowing pre- and post-visit class visits to take place on the Monday and Friday of the same week. Likewise for days 4-6; combined visits were carried out during one week, approximately one and a half months after the first block of data collection.

I chose the research design shown in Figure 3.3 because it would allow me first to identify the learning in each setting and then to identify the learning in combined settings. This allows for the identification of learning that occurred in one setting as follows:

Example: Learning in environment exploration, EE, is given by Code totals from children who have taken part in an environment exploration minus Code totals from those who have not taken part in an environment exploration, i.e. (EE + EENH + EELA) - (NH + LA + NHLA).

These calculations acknowledge a possible interaction effect, and allow for this by focussing on learning that was common to children who took part in both single sessions and also combinations of sessions.

The choice of methods was informed by a pilot study which took place in July 2011 at the Natural History Museum and NHM wildlife garden, in London.

3.6 Pilot Study

The pilot study aimed to inform the methodology for the thesis. The existing literature in formal science teaching, informal and outdoor science communication and learning around biodiversity and sustainability, as reviewed in Chapter 2, informed the choice of focus, methodology and analysis. The findings of this pilot study are analysed and discussed at this stage, in order to start to consider themes which will be raised by the main data collection.

The research question for the thesis to address is as follows: *What do children learn about biodiversity in informal learning settings?* The pilot study focuses on a sub question: *Is there a benefit to primary children when indoor and outdoor learning about biodiversity are linked, on a school trip?*

The decision to investigate combinations of activities was based on the survey of education providers for the International Year of Biodiversity, 2010 (Sim, 2011). Biodiversity educators recommended giving children opportunities to be outdoors:

> Outdoor learning and first hand experiences of biodiversity are best.
>
> Let them go outside and do it in a practical capacity. In a classroom is never as stimulating as outside and in nature.

> Let them experience biodiversity first hand. Get them out into the countryside.
>
> (2011:16)

In addition, there was support for the use of 3D artefacts, for example:

> The use of more props during school talks and encounters would be a great benefit, encouraging more interactivity with children and the topic of biodiversity. We ourselves have a great number of props many of which have been donated through customs and we're always striving to develop new ideas and props to use.
>
> (2011:16)

The pilot study presented in this chapter took place in the Natural History Museum (NHM) in London. NHM is a national museum with approximately four million visitors a year. The public can see aspects of the natural specimen collection, which contains over 70 million objects. The scientific research departments at the time of this pilot study were Zoology, Botany, Entomology, Palaeontology, Mineralogy and the Library. At the time of writing (2012) NHM received funding from the Department for Culture, Media and Sport (DCMS) to offer free education activities which approximately 150 000 pupils and other members of the public take part in each year. The pilot study focused on informal teaching for primary pupils – age 9 years – about habitats (where organisms live) and adaptations (how organisms are suited to where they live); therefore, in this particular case the natural history specimens in question are confined to natural objects relating to zoology and botany. The living species are typical English plants and wildlife found in the Wildlife garden of the museum. This research aims to examine learning by pupils who participate in informal biodiversity education sessions. The wording has been chosen to allow exploration of the changes in pupil thinking, using grounded theory for analysis at the pilot study stage.

Historically, lessons at the Natural History Museum involved both indoor museum learning and outdoor learning in local parks about British species. Jacqueline Palmer, NHM educator in the 1950s, offered series of lessons alternating environment exploration with gallery sessions (source: NHM archives; Palmer, 1954). Given the different traditions of learning relating to similar biodiversity content, explained in Chapter 2, my interest is in what the benefit might be to pupils of combining specimen handling with environment exploration.

This pilot study aimed to explore research methods to investigate the specific aspects of learning for a class of pupils taking part in an environmental exploration, comparing the results with a class taking part in a combined session that includes natural history specimen handling (NH) *and* environmental exploration (EE). This is shown in Figure 3.4.

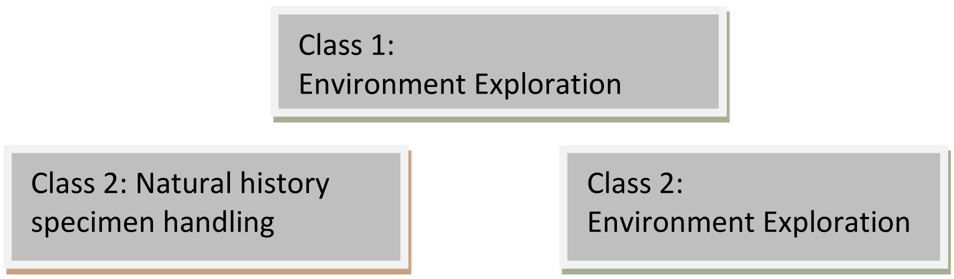


Figure 3.4 Illustration showing that Class 1 took part in environment exploration alone while Class 2 took part in both specimen handling and environment exploration

Comparing the responses of children in the two different groups offered insights into whether or not there is a benefit to combining more than one informal method of learning about the natural world. This chapter presents trial methods to investigate two classes' experiences, and analyses the results. Revisions to the methodology for the subsequent main phase of the research will be described and explained. Initial conclusions were drawn from evidence, showing that natural history collections can increase pupils' ability to identify species, and that environment exploration activities can confer motivating and positive associations with nature.

This pilot study had the following aims:

a) To investigate the practical considerations for comparing learning by two classes;

b) To trial methodology for comparing benefits of learning experiences about nature:

i) refining pre- and post-visit survey activities

ii) coding oral records and visual observations

iii) using the MLA Inspiring Learning for all Framework for subsequent analysis.

Context

The pilot study took place with London school pupils aged 9 at the NHM and in the NHM Wildlife Garden. It focussed on local habitats and species. In both sessions, pupils split up into groups to explore one habitat in depth. The specimen handling session included crates containing plant and animal specimens specific to each habitat that can be found in the wildlife garden at NHM: Chalk Downland, Fen, Heath, Meadow and Woodland. Class 1 took part in an environment exploration activity only – see Figure 3.5. Class 2 took part in a specimen handling workshop (see Figure 3.6) prior to visiting the wildlife garden for an environment exploration activity.

Figure 3.5 Groups in the wildlife garden at the Natural History Museum; both classes 1 and 2 from the pilot study participants did this activity

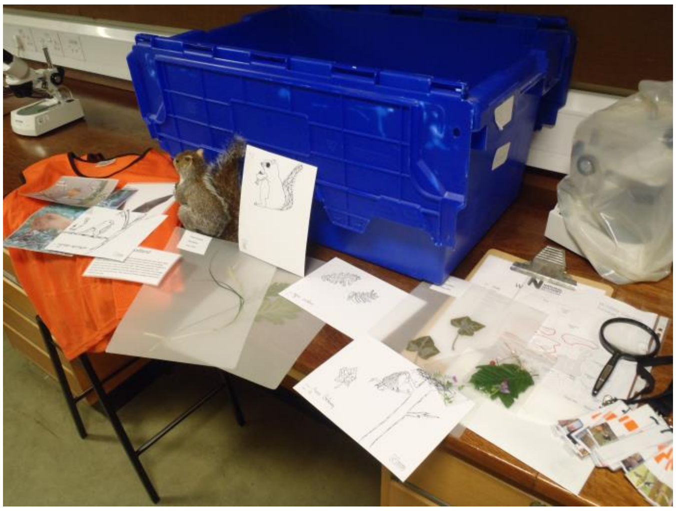


Figure 3.6 Natural history specimens and activities from the team looking at 'Woodland'; only class 2 from the pilot study sample took part in this activity

All children were from London schools. The choice of participants will be considered further in the discussion section.

Methods

Figure 3.7 illustrates the research design, which is based on a qualitative pre and post-test model with comparison groups, triangulated using ethnographic methods of observations (Barriault and Pearson, 2010) and audio recording. Being aware of criticism in the literature of positivist, quantitative approaches to environmental education research (Rickinson, 2003), the design of this pilot study includes two methods that incorporate an interpretivist approach: verbal and visual analysis. However, at this stage in the research, hermeneutical approaches to coding data will be used.

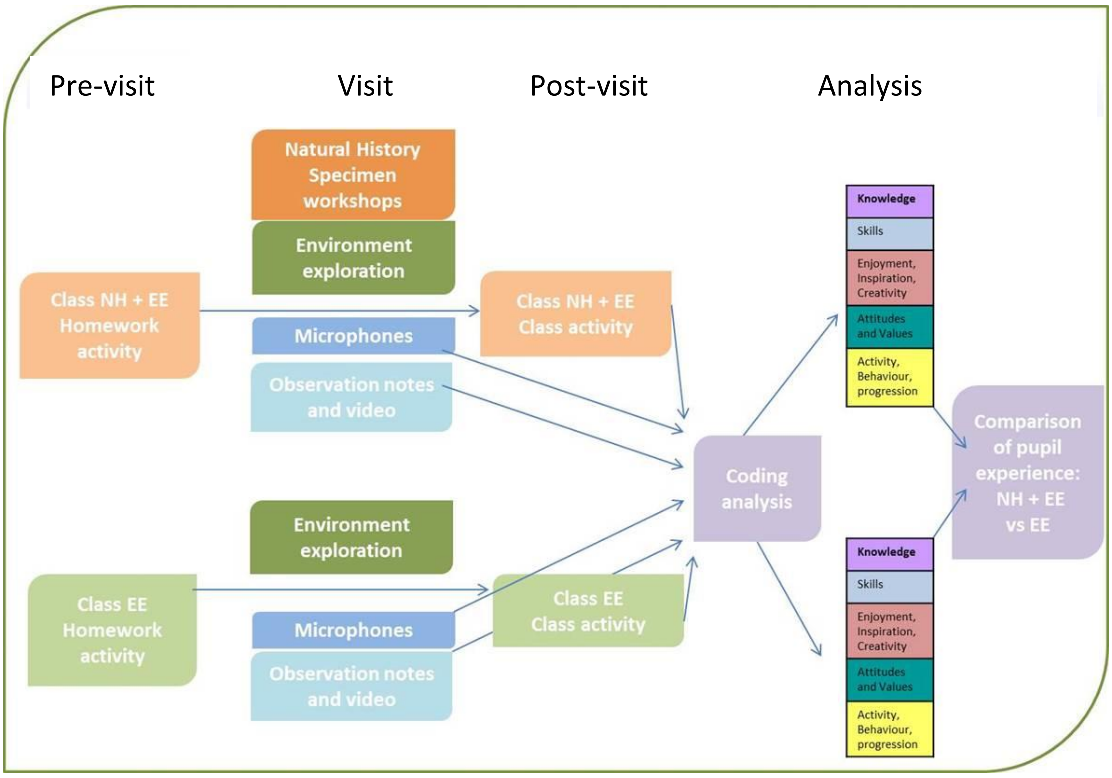


Figure 3.7 Pilot study research design and analysis

It is intended that this combination of methods will provide insight into the process by which learning occurs in the different sessions, which was highlighted as a gap in research by Rickinson et al. (2004); these authors also identified the relationship between indoor and outdoor learning as a 'blind spot'. The research design will therefore enable this study to be of value in adding to the body of research around outdoor science learning.

Open activity design

It could be argued that tests with 'correct answers' are likely to show post-test increases owing to familiarity with questions. For example, Vaughan et al. (2003) tested pupils and parents about Scarlett Macaw knowledge before and after informal science teaching about their conservation. They found consistent increases post-test which they attributed to the effect of the teaching sessions. Therefore, for this study pre- and post-visit activities were deliberately designed to allow open responses rather than use Likert scales or binary responses. Whilst open questions take longer to analyse, I felt it was important at the pilot study stage to allow for a range of responses in order to understand participant's prior experience and learning.

The procedure used for data collection in the pilot study is summarised in Figure 3.7. Initially, permission was sought from parents for their child's participation via a letter explaining the research. This letter also included permission requests for photographs to be taken. Homework activities were given to schools, to be completed by pupils one week before the visit, with the aim of understanding their prior knowledge about habitats and adaptation. This was planned to gather evidence to relate this study to the literature about children's conceptions (Chapter 2). The pre-visit activities consisted of two parts:

1. An A4 sheet of paper with a mind map prompt in the middle: 'What do you already know about the animals, insects, birds and plants that live near you?'. Pupils were asked to record their associations with living things on this sheet. This is inspired by Personal Meaning Mapping (Falk and Dierking, 2000). See Figure 3.8 for an example.

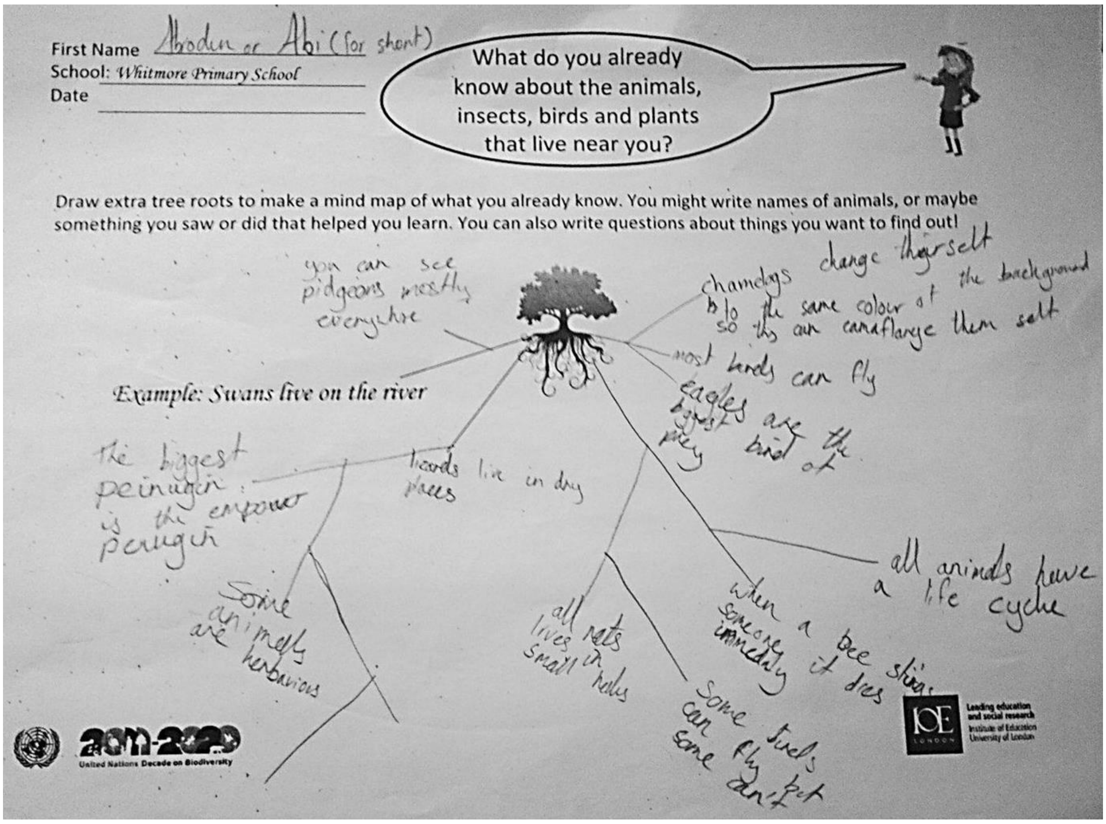


Figure 3.8 Example of a pre-visit mind map

2. A mapping activity. Pupils were asked to sketch a map of their journey to school, marking with an x and labelling where there was an animal or plant species that they recognised. See Figure 3.9 for an example.

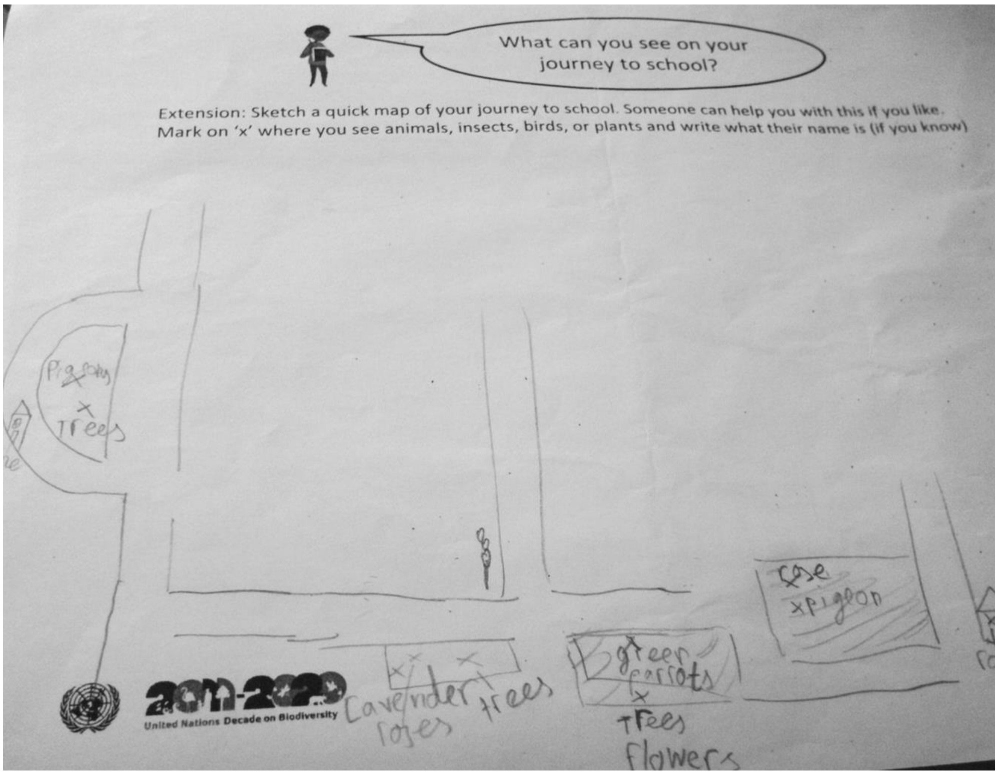


Figure 3.9 Example of a representation of a pre-visit journey to school

Post-visit activities again repeated activity 1. After pupils' visit, this mind-map style activity was carried out in class, rather than homework. Pupils were asked to record their personal associations about wildlife. Activity 2 asked pupils about their visit, using MLA framework headings to design questions under the headings of: knowledge and understanding; skills; activity, behaviour, progression; enjoyment, inspiration and creativity; and attitudes and values.

Observations were based on short video clips, taken by an assistant. She had been asked to record two-minute clips when children were taking part in an activity, but when there was little conversation. The aim of this was to complement the data from microphones. One boy and one girl from each class were chosen at random to wear microphones, which were fitted at the start of the session.

Results

Results will be discussed under the headings of the Museums, Libraries and Archives (MLA) framework 'Inspiring Learning for all: Generic Learning Outcomes'. In each case, insights gained from pre/post activities will be considered, followed by microphone data and finally observations. The differences between the two groups, Class 1 (EE) and Class 2 (EE + NH), will be examined. Similarities and differences will be highlighted. In each scenario, the null hypothesis is that there is no difference between groups. The active hypothesis is that there is a difference and, if so, the aim of this research is to establish the precise nature of that difference. At this early stage in doctoral research a grounded theory approach was used, to assign categories in response to pupil responses, rather than attempt to fit observed data into a preconceived coding structure. Data are presented in the form of descriptive statistics. The resultant categories of information are then used to inform the subsequent stages of research.

Since the pilot study addressed the following question: *is there a benefit to primary children when indoor and outdoor learning about biodiversity are linked on a school trip?* It is useful to present data according to the activity that pupils took part in, as in Figure 3.10.

MLA domain	Both classes	Class 1 EE	Class 2 EE NH
Knowledge and Understanding	Habitat	Behaviour	Types of Science Name Prior knowledge
Skills	Discovering Questioning Describing Giving instructions	Seeking Listening	Observing Identifying Teamwork Drawing
Enjoyment, Inspiration and Creativity	Excitement searching for species	Seeing living species	Using equipment, imagination
Attitudes and Values	Computers, museums and gardens as ways to learn about nature Fear Caring Expectations	Books and visiting parks as ways to learn about nature	Exploring and looking as ways to learn about nature Nature of science Dissonance in attitude to taxidermy Native species Views of creation Value of nature Humans as nature Human-animal interaction
Activity, Behaviour and progression	Cognitive understanding progression Social learning: -repetition -showing peers -calling peers	Motivation to explore Disagreement Ownership	

Figure 3.10 Summary of pilot study results, analysed using the Museums, Libraries and Archives framework. This figure is a summary of information presented subsequently in figures in this section, which use evidence in the form of pre- and post-visit activities, and conversations recorded on microphones, to assign 'codes' with which to analyse data.

Results will be discussed sequentially using Figure 3.10 as a basis, with evidence that is relevant to both classes presented first, followed by differences in the two groups.

Knowledge and Understanding

Both classes showed evidence of learning about habitats. The clearest evidence for this was the high number of mentions of habitat types such as Fen and Woodland, both in recorded conversations and in post-visit class activities. There were no mentions of these habitat types in pre-visit activities; therefore children did advance in their understanding of habitat types and vocabulary through outdoor exploration and specimen handling.

Class 1 EE pupils also included comments about animal behaviour and movements using verbs and phrases such as ‘making a nest’, ‘flying’ and ‘jumping’. Class 2 EENH mentioned disciplines of science in post-visit activities, such as ‘zoology’, which was mentioned in the specimen handling session to explain the purpose of natural history collections.

Skills

Children in both classes showed evidence of using skills of discovery, questioning, describing and giving instructions. One of the initial aims of this pilot study was to practice coding information, taking a hermeneutical approach. When analysing data, three types of evidence were counted as ‘discovery’: the phrase ‘I found a …’ in post-visit activities; video evidence of children finding a living thing; and microphone evidence by way of exclamations to indicate that a living species had been seen. The authentic experience of finding a living thing in a wildlife garden excited children considerably. Figure 3.11 shows a group of children who have found a frog by rolling back a log.

Figure 3.11 Children in Class 1 EE find a frog during the pilot study data collection in the Natural History Museum wildlife Garden, summer 2011

Class 1 EE were also heard to say phrases such as ‘shh, listen’ and seen in video evidence actively to look for living things (e.g. Figure 3.12). Therefore, I have concluded that pupils in Class 1 used seeking and listening skills.

Figure 3.12 Seeking skills in Class 1 EE during the pilot study data collection in the Natural History Museum wildlife Garden, summer 2011

In addition, the pupils in Class 2 EENH were heard to identify species, using knowledge from having handled specimens and drawn them, in team activities prior to visiting the garden. Figure 3.13 shows a drawing and statement about adaptation using a specimen from the ‘woodland’ team. The initial experience of using species names seems to have encouraged children to experiment with assigning these scientific words to real world biota.

Figure 3.13 Observation and the development of drawing skills, using specimens during the pilot study data collection in the Natural History Museum, summer 2011

It seemed that a lot of the teamwork (working together to achieve a task, for example rolling a heavy log to see underneath) was cemented during the early stages of the session, when collaboration was necessary around access to limited resources in the natural history handling session. Not surprisingly, children tended to describe textures of specimens and colour, if they had not previously experienced natural history specimens.

There are a large number of ‘skill’ codes, and the assignation of some social skills to this area of the Generic Learning Outcomes Framework is open to debate. The discussion section will propose an alternative framework for future research, based on the degree of subtlety in community skills developed, which are at risk of being overlooked using this framework.

Enjoyment, Inspiration and Creativity

Figure 3.14 shows the evidence for enjoyment for both classes, using all three methods of data collection (microphones, video and pre/post-activities).

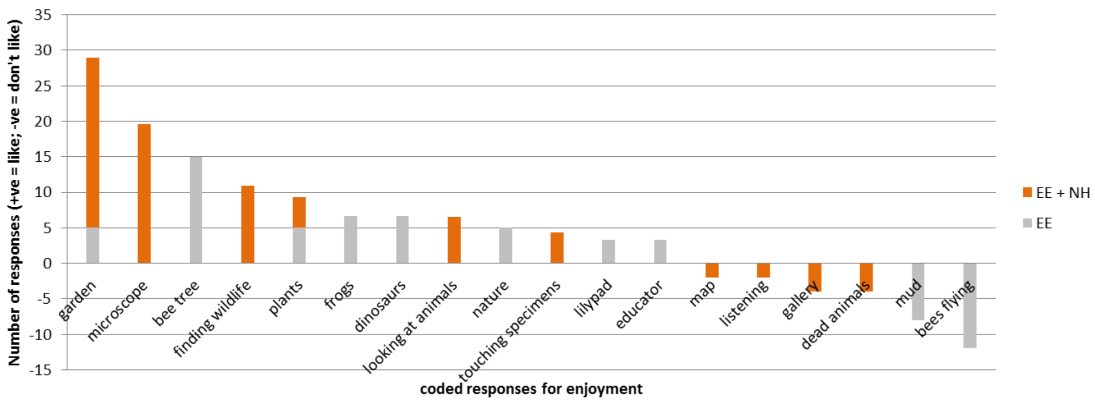


Figure 3.14 Enjoyment for both classes. This graph includes evidence from all three methods of data collection (microphones, video and pre/post activities). The number of responses shown on the y axis is obtained by subtracting the number of negative responses from the number of positive ones. The sample size is 60 pupils from both Class 1 and 2 (pilot study sample).

The environment exploration aspect was clearly the most enjoyable, and using scientific equipment to examine specimens was also rated highly by the EE+NH Class. Finding wildlife, looking at animals and touching specimens were enjoyable aspects cited by the group that took part in a combined trip. Examples include:

> I enjoyed going to the wildlife garden and looking at lots of different plants.
>
> (EENH pupil)

> I enjoyed stroking the pigeon.
>
> (EENH pupil)

Not surprisingly, the fact that many of the animals were dead was a negative factor. Additionally, the wildlife garden at the NHM is home to a tree trunk with a honeycomb inside, which you can see when you open disguised doors on the outside. This was popular with children, but conversely they did not like the perceived threat of the bees flying around:

> What I enjoyed most was looking at the beehive even though I screamed.
>
> (EENH pupil)

Surprise is a factor that increases salience, even when the animals are not dangerous:

> I enjoyed seeing the frogs jumping about everywhere under the logs.
>
> (EENH pupil)

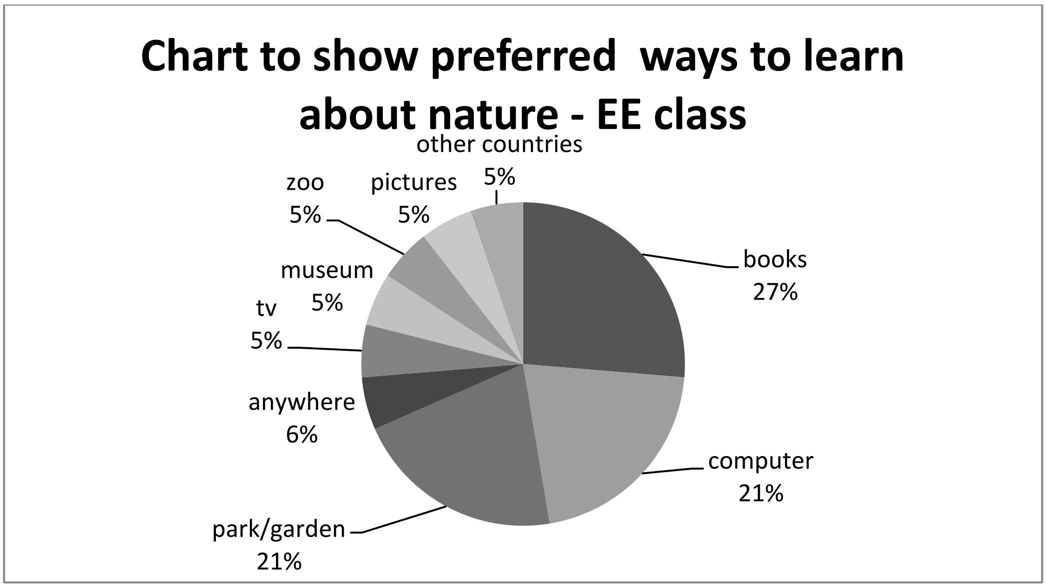
Mud and noise from other children were also negative aspects for the EE Class 1.

A major source of enjoyment remained the outdoor part of the session for the EE+NH Class 2; the comparison with being inside increases the number of positive comments about being outside.

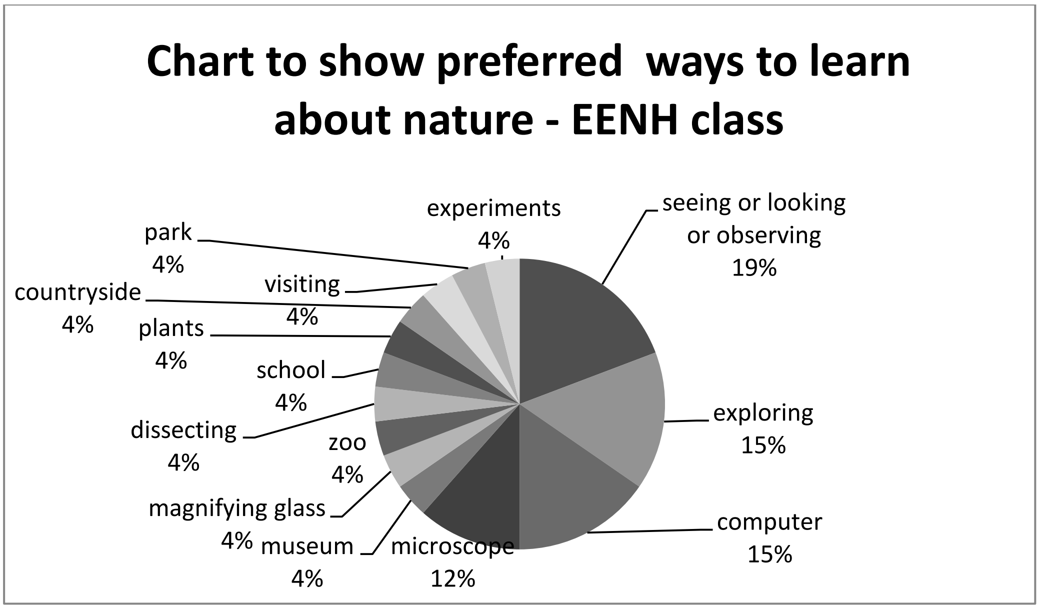
Listening to what pupils said, there were a number of comments that were coded as evidence for enjoyment, inspiration and creativity. The excitement of discovering living things could clearly be heard and, by using the same comparison method as before, it is clear that this effect was more noticeable for Class 1 EE. There were relatively few comments in the session that indicated likes or dislikes, although there was initial apathy in the environment exploration, owing to not having seen any animal species at the start of the session! A source of dislike in Class 2 EENH was the taxidermy. Some pupils reacted positively to specimens (although not initially) and commented anthropomorphically about the natural objects. Visual evidence confirmed that pupils in both groups enjoyed the experience of being outdoors and exploring, as judged by considerable enthusiasm. One part of the picture which was not captured by other methods is the observation of solitary pupils exploring very happily, which would not be easy to gather through microphone evidence, for example. This observation will be used to reassess data gathering methods.

Attitudes and Values

Much of the data about attitudes and values in the existing literature has relied on Likert scales and pre/post questionnaires that allow little space for personal responses outside of the preconceived framework (see, for example, Boeve De Pauw, 2011). From personal experience with front end evaluation at NHM, I had observed that attitudes and values were less likely to appear on concept maps. Therefore I had asked post-visit questions to better understand children's attitudes around preferences for learning about the natural world. The results are shown in Figures 3.15 and 3.16.



Figures 3.15 Preferred ways to learn about nature – Class 1, which took part in an environmental exploration (EE) only. This represents half the pilot study sample, so it is based on 30 pupils.



Figures 3.16 Preferred ways to learn about nature – Class 2, which took part in an environmental exploration (EE) and natural history specimen (NH) activity. This represents half the pilot study sample so it is based on 30 pupils.

I had not anticipated the range and scope of attitudes that would be revealed by listening to pupil conversations around the two types of visit as shown in Figure 3.17. Attitudes around key facets of biodiversity, native species, use of natural resources, ownership and fairness were themes covered as children encountered specimens and investigated outdoor space. As a result, I decided that for the next stage of research, the large number of codes generated in the 'attitudes' domain would be used to devise questions to probe children's understanding of environmental issues, but in an open response format. The discussion in this chapter will show how the strands of discussion by children relate to existing research.

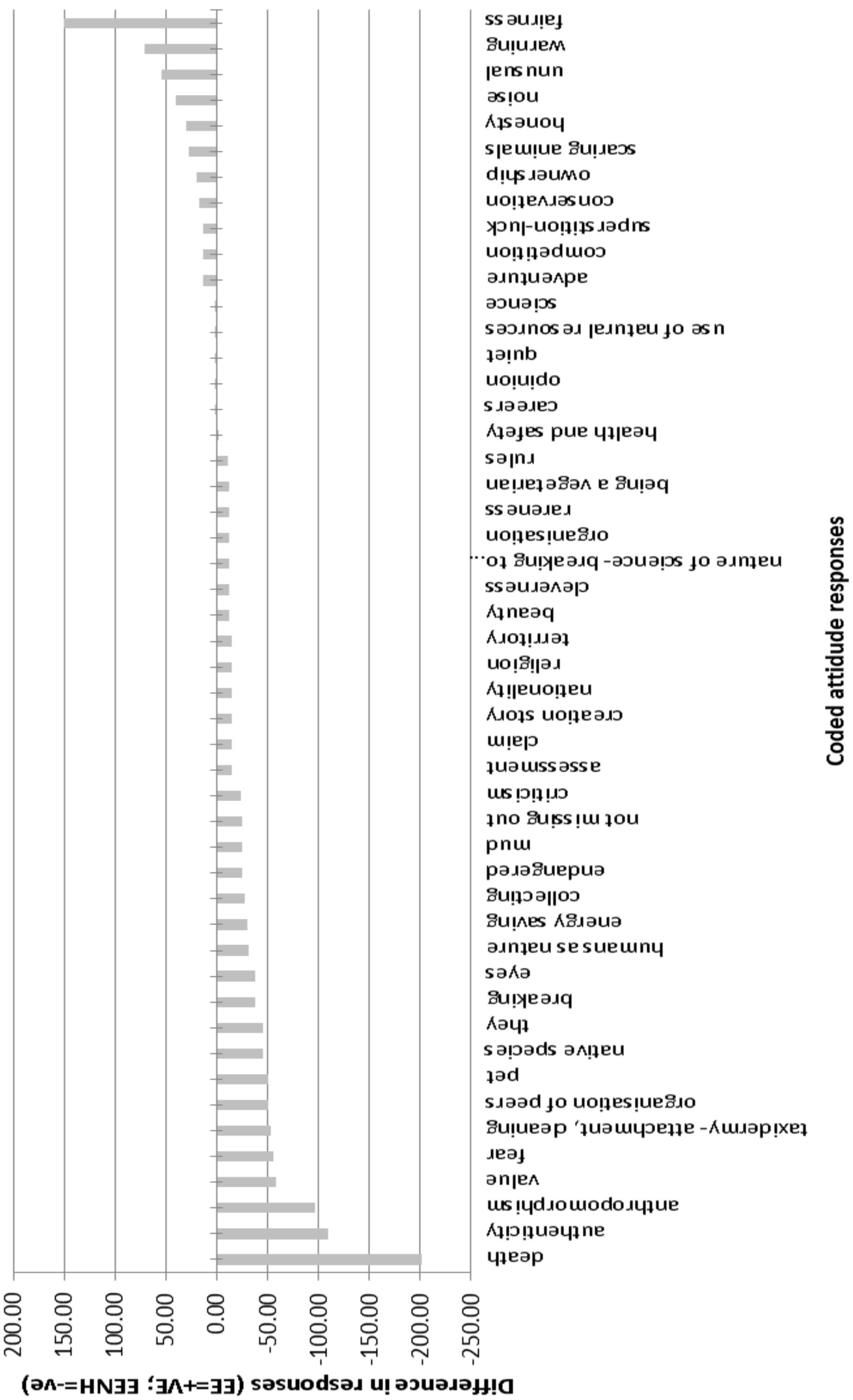


Figure 3.17 Attitude codes in conversations. The difference between the conversations has been calculated by subtracting the EENH class' number of responses from the EE class'. Therefore, the most negative responses are those where children have encountered EE and NH, and most positive responses are those seen in EE only. This represents data from all 60 pupils in the pilot study sample.

I observed evidence of a range of responses to nature, with some children wanting to damage living things as a first response, only to be told not to by their peers. The following section will explain some of the viewpoint-resolving behaviours which children used in both types of session.

Activity, behaviour and progression

Both classes showed considerable evidence of social learning. Class 1 EE particularly showed evidence of motivation to explore, but also disagreement and disputes about ownership (‘It’s mine!’ ‘I saw it first’, etc.). Progression can be determined by comparison of pre and post-visit responses about knowledge and skills, which have already been discussed. I have taken activity and behaviour to refer to the nature of learning – what is it that children are actually doing whilst taking part in either visit? Therefore, this section does not include written pupil self reports; instead, oral and visual evidence will provide evidence. Oral evidence shown in Figure 3.18 shows the nuances of social behaviour that are involved in agreeing where to go, what something is, who saw it first and so on.

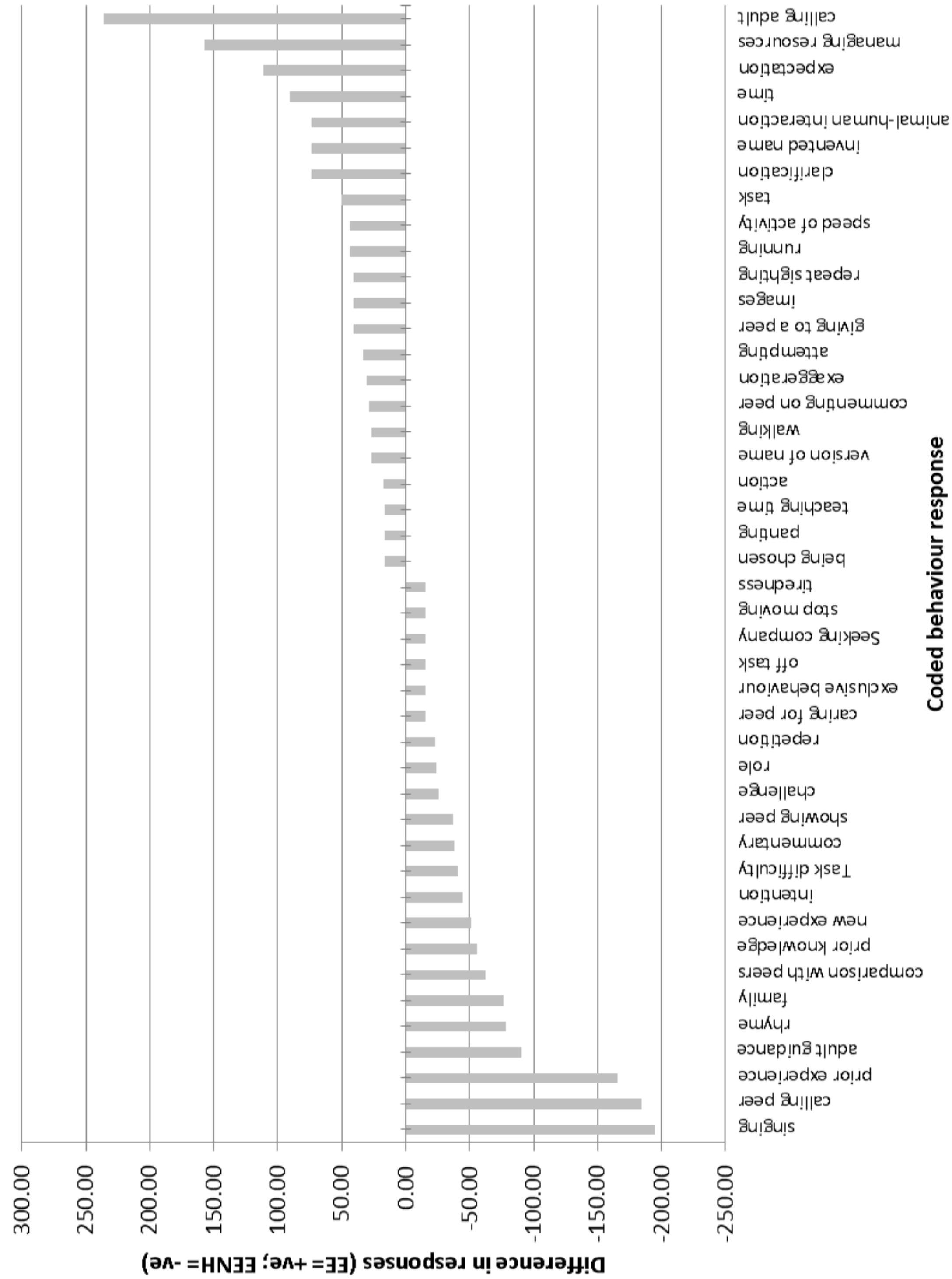


Figure 3.18 Behaviour codes. The difference between the conversations has been calculated by subtracting the EENH class' number of responses from the EE class'. Therefore, the most negative responses are those where children have encountered EE and NH, and most positive responses are those seen in EE only. These data come from all 60 pupils in the pilot study sample.

The appearance of singing and using rhyme took place when children were moving between the natural history collection and the environment exploration. One explanation of this is to do with the aural feedback loop in memory; children may have been using these methods as a way of retaining information about new words. They made up songs that were to do with what they were seeing, and repeated phrases with changing emphases. In addition, another mode of meaning making took place in Class 2 EENH – referring back to holiday or other prior experiences as a frame of reference for new information. The role of adults is clear for Class 1 EE, whereas Class 2 EENH group were more likely to call peers. This may be because pupils in different teams in Class 2 EENH saw different local specimens in the natural history collection; therefore, children could feasibly have taken on roles as experts. In contrast, pupils in Class 1 EE would not have seen their peers as experts about local information. Expectation is a major component of environment exploration, as the situation is authentic; wildlife cannot be ordered for a time and place. Therefore, disappointment may result for pupils with high expectations about the number of species they will see. There was discussion comparing expectations with reality in the EE sessions, with some pupils saying 'I thought that I would see a …'. Seeing a natural history collection first meant that children had already learnt about factors that would reduce the likelihood of seeing certain species, e.g. nocturnal or migratory animals.

I have also included evidence of health activities in this section, for example, when children talk about walking, or run. I included the code 'panting' when the pupils were out of breath (clearly heard on the microphone) after what was actually only a small amount of exercise. This has implications for relating this research to work that looks at the connections between nature and health. It is noticeable that there are a great many categories in the section 'Activity, Behaviour and Progression', and the need to put social behaviour in with physical activity suggests that a modified framework for analysis is required for the next phase of this doctoral research. By observation, it was clear that pupils became experts at various points; the person who had made a sighting was temporarily the group leader in pointing out the species. Initial excitement at seeing living things scared off many of the butterflies and birds at first, but over fifteen minutes pupils gradually behaved more calmly in order not to frighten the animals. It was clear that children who are relatively quiet and can engage in sustained observation were particularly good at seeing specimens, and they gained temporary kudos from peers by sharing sightings. The following section will explain how summed evidence gives insight into the nature of learning across both groups.

The nature of learning

Figure 3.19 shows the 25 most frequent codes that appeared for all four pupils who wore microphones. It is clear that there is discussion around species identification, and that repetition plays a strong role in the process of assimilating the new information. One notable factor is ownership, that is, the importance of the identity of the person who saw or correctly identified something. If pupils saw the animal or plant themselves, they were frequently very excited about it and wanted to tell everyone. Although sessions had been planned to have as much free choice exploration as possible, adult helpers assisted children in recording who had seen each thing, and asked children who had seen a lot to 'give' one of their sightings to children who had not, so that they could draw something (which was optional). The role of showing peers was a context for repetition, so that information travelled around the groups in cycles of pupils becoming expert and passing on expertise, the process of teaching cementing the learning. In terms of categorisation, repetition often happened with sentence structure as well as name labels. In one example, a pupil said 'a fox is a mammal' and variations with substituted animal nouns could be heard until the extent of the category was found.

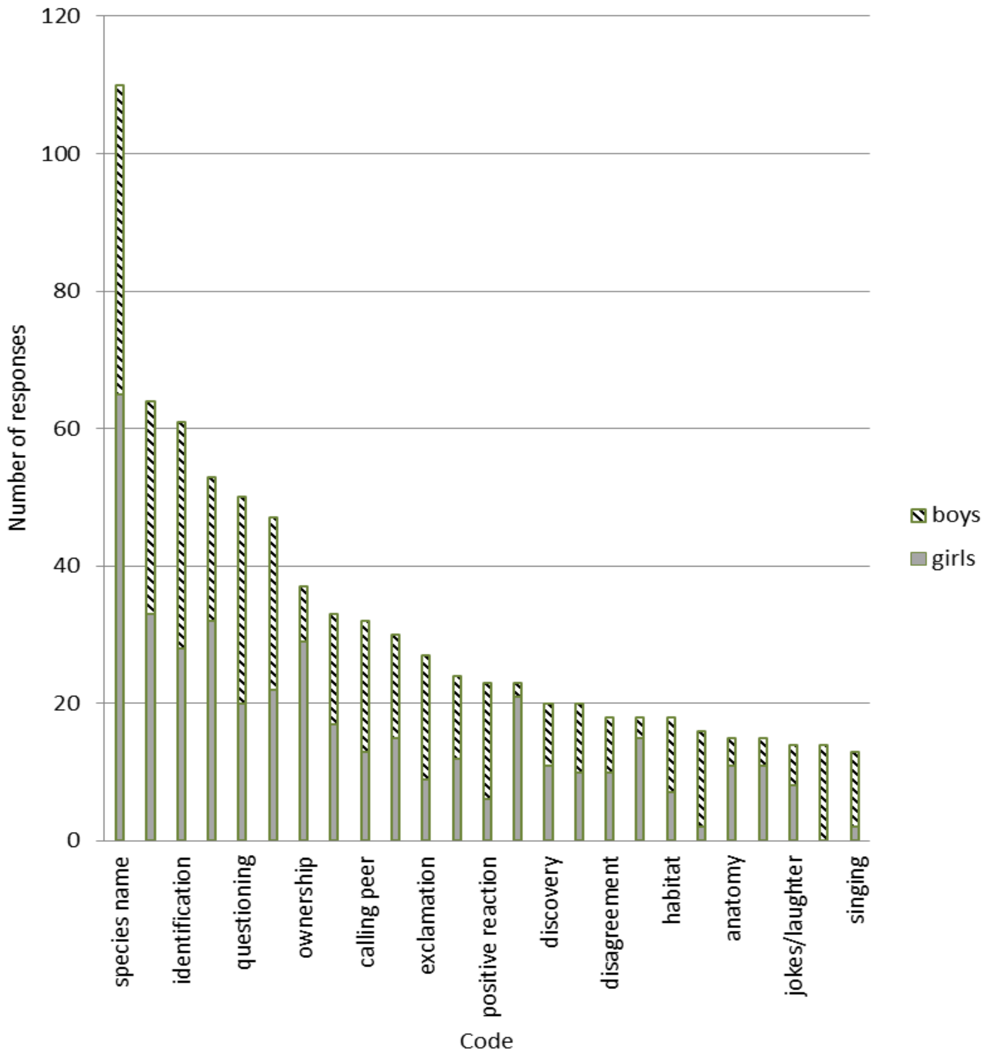


Figure 3.19 The most frequently occurring conversation codes; data from one boy and one girl from each of two classes (four pupils in total) who wore microphones during their biodiversity activities. Pupils were from the pilot study sample classes.

Discussion

This pilot study discussion will relate benefits to pupils from taking part in an environmental exploration and a natural history collection handling session to the existing literature. Results are being considered in detail at this stage to lay foundations of understanding for analysing the main data in the thesis. The preliminary conclusions from this pilot study show complementary benefits to pupils taking part in environment exploration and natural history specimen handling, the former providing motivation and the latter providing skills for identification.

In this small-scale study involving two Y5 (age 9/10) classes, one of 29 and one of 28 pupils, the group that took part only in an environment exploration developed knowledge about habitats, new words and animal behaviour. Discovery skills were reported by pupils and heard in recorded conversation. Self report also showed an increase in questioning after an environment exploration. Through observing pupils, it was clear that they developed map skills. The enjoyed the experience of being in the garden, and recalled enjoying seeing different species (particularly bees), but some pupils did not like insects flying around them. Likewise, the presence of mud was a negative aspect. Their self-reported attitudes towards learning showed that 21% of responses cited parks as places to learn about living things. Other attitudes revealed through oral recording included the importance of fairness, the desire to see something unusual and positive attitudes around conservation. Video recording showed a surprisingly high proportion of fear or negative attitudes to wildlife, which were often challenged by peers. Social behaviour showed development of community skills, such as giving to a peer. In the environmental exploration group, pupils were more likely to call for adult assistance.

Addition of a natural history collection specimen handling session, which took place prior to the environmental exploration, led to a difference in pre/post-visit knowledge. The greatest increase in reported knowledge was around species name when pupils used personal meaning maps and these were analysed using hermeneutical coding. Like the environment exploration group, there was an increase in knowledge of habitats, which is encouraging given that this was the aim of the session from a school curriculum perspective. Pupils commented more than in the EE class about anatomy and adaptation. They reported increases in observation skills and discovery, and microphone evidence showed that they developed teamwork skills around access to resources. Pupils were more likely to demonstrate classification and identification skills. This is consistent with Class 1 EE pupils saying they were unsure what something was or inventing a name more often, for example “it’s an ant-fly”. Assigning tags experimentally is consistent with Ash’s (2007) work on thematic continuities, showing that children’s use of scientific vocabulary develops on a sliding scale as they gradually assimilate useful ideas and words.

The lack of ability to identify species did not appear to diminish overall enjoyment of the session for Class 1 EE pupils, who produced a high percentage of positive responses when discovering species. The attitudes to learning of Class 2 EENH showed that they cited scientific skills (exploring, looking, using microscopes) when asked how they preferred to learn, whereas Class 1 EE stated locations (park, garden, at the computer) rather than methods of learning. Attitudes revealed through conversation showed opinions about native species, stories about creation and views on vegetarianism. Pupils were most concerned about the origin of the specimens and their authenticity. Personal learning took place through performance and rehearsal in a number of forms: showing peers, talking about prior experience, and singing or using rhymes. The critical role of peers in making meaning is consistent with Johnston (2009), who similarly found a ‘Chinese whispers’ type effect in place when children were developing observation skills.

The nature of learning taking place across both groups was established by summing the responses of all four pupils who wore microphones, giving a total of 2778 individual items of data. The most common categories of conversation across both groups were species name, repetition, identification, observation and questioning.

There appears to be a benefit to pupils when natural history specimens are provided for children to investigate prior to a habitat exploration, in terms of children then being better able to identify specimens and talk about scientific skills. However, these results have also yielded insight into the suitability of the methods used to gain useful information. This discussion will justify the use of a different framework for analysis, and argue that it is necessary to analyse progression individually. Self-report pre/post activities will be modified, and the verbal/visual methods will be changed to include two continuously running video cameras, one from a learner’s and one from the educator’s viewpoint.

Common aspects of learning in specimen sessions and environment explorations

Progressing from children's prior knowledge about their environment

The concepts of habitats and adaptation are acknowledged to be stepping stones towards understanding more complex understanding about ecosystems and inter-relationships (Barker and Slingsby, 1998; Anderson and Whitmer, 2009). Children will possess predictable prior knowledge about both habitats and adaptations (Driver et al., 1994). The nature of existing conceptions was discussed in section 2.1. I recorded prior knowledge as a baseline against which to judge the effects of the two treatments EE and EENH. It is reassuring that the overall pattern in knowledge progression that resulted when children wrote down their pre- and post-visit associations matches accepted ideas in terms of the concepts children should or could learn sequentially. The largest proportion of responses were names (group descriptions such as animals, insects, birds), followed by species names (frog, newt, rabbit), habitats (e.g. fen, chalk downland, woodland, meadow, heath, pond), then extending through ideas around movement, sensitivity, growth, reproduction and nutrition. (Excretion and respiration were not mentioned.) Both types of experience (EE and NH) increased the spread of knowledge responses towards more complex ideas. However, there are clear differences in pupils' levels of prior knowledge. One criticism of the method used is that children completed pre-visit activities for homework. In this scenario, differences in the level of family support would be most pronounced. For example, one child copied many species names, apparently from an internet search. If this comparison was done in the classroom, then the conditions for completing the pre-visit activity would be more similar and therefore fairer.

The pre-visit associations revealed a wide spectrum of knowledge, with differences in levels of knowledge that did not correlate with literacy skills (as judged by levelling writing – National Curriculum guidance, Department of Education, 2011 – and speaking with the class teacher). For example, one child in Class 1 EE wrote many sentences with several levels of understanding such as “if a monkey get sick he know which leaf to use as a atidot [antidote]” amongst a web of connections that revealed considerable knowledge. The source of this knowledge was not clear, although from the children’s reported comments it may have been through books or TV. Children commented on family learning about wildlife and nature, through visits. In the literature the considerations around cultural and indigenous approaches to learning about nature (Chand and Shukla, 2003; Xuehua, 2004; Singh, 2010) would also be appropriate to use as a basis for research when working with multicultural classes. Collectively, a field of research about integrating cultural and indigenous knowledge shows the importance of respecting intergenerational learning, and making the effort to highlight similarities and parallels between what pupils already know and new experiences. Such a model is based on a constructivist learning approach, as discussed in the literature review. One of the teaching assistants said that she came from Nigeria, and started to explain that the trees in the wildlife garden had just reminded her of this. Acknowledging this diversity and facilitating scenarios where children can start by sharing their prior knowledge (for example, talk partners) is therefore beneficial both to pupils in making links through talk and for educators to assess rapidly which links will be relevant to pupils, a key skill when there is only a short time to make a relationship with the class. This pedagogical approach will not be at all new for teachers, although, in my experience, surprisingly few informal science sessions start with the chance for all pupils to talk; frequently, there is a question-answer session which is based on a didactic approach. This is not only the case in England; Okur et al., 2011 studied biodiversity education at primary level in Turkey and found that traditional teaching methodologies were used. The diversity within London classes and the likelihood that children will have expert knowledge about specimens or species leads to a recommendation across both EE and NH sessions for a starting activity that acknowledges pupils’ expertise and positions them as a source of information. The models of learning being used borrow from Bruner’s Discovery Learning (1967) and Vygotsky’s social learning theory (1978).

It is clear from the evidence I gathered that social learning (Vygotsky, 1978) plays a major role in allowing children to construct meaning from the language and physical experience of both NH and EE sessions (Gredler, 2012). There were cycles where a living thing was given a name or description, which could then be heard being passed on round the group, from peer to peer. A typical exchange would involve some discussion of what the thing was, before settling on an answer, correct or invented, which was then pointed out to others within their sub group (team) and to friends in other teams. There is evidence to suggest that the phonological loop involved in working memory (Baddeley and Hitch, 1974) is implicated, because the NH groups were heard to rehearse invented rhymes and song, playing with phonemes, using new or re-encountered words. Therefore, the chance for children to rehearse what they have learnt in meaningful social contexts or creatively in rhymes is an important part of pedagogy around developing associations between visual and oral information.

Grace (2009) investigated the nuances of discussion in developing decision-making abilities about conservation with secondary school pupils and teachers in England. This could be extended to some of the early conversations about attitudes to wildlife for primary pupils from the video clips – "I'm going to stamp on it" followed by "don't do that". The role of disagreement in conversation arose for both Classes.

3.6.1 Conceptual Framework for analysis: society and environment

Children were particularly surprised by the concept of humans as part of nature, which suggests that they are not accustomed to categories of environmental education such as Sauvé's (2005) that include humans and their actions in the environment. One question this pilot raises is about the relationship between humans and the environment; given that this is a key idea for long term sustainability, are these ideas currently easily presented in a way that is accessible for a primary age audience? Various models of socio-ecological literacy have been proposed, for example, ecoliteracy (Peacock, 2004) and Anderson and Whitmer's (2009) model of socio-ecological progression. Common to models is the basic unit of understanding inter-relationships, an awareness of plants and animals as the building blocks of food chains, then webs, then ecosystems, then the interconnection of ecosystems. One model stands out in its specificity concerning the types of social behaviour that children and young people would need to develop to suit the globalised, pluralist pervading worldview of today, and to be able to adapt to rapidly changing conditions mediated by technology. Nichols and Zeidler's (2012) Earth Smarts model includes the following domains: Competencies, Concepts, Sense of Place, and Values. It is particularly striking that the community skills cited (empathy, involving, balancing views, language, argumentation, group work, collective intelligence, conceptualisation and justification) were a large component of the behaviours that were observed and listened to in both EE and NH situations. Therefore, this framework is likely to prove a more suitable model for analysis of informal learning about the natural world, as it is specific in terms of social and environmental skills, cognitive concepts and affective attitudes towards place.

Figure 3.20 shows the conceptual relationships in the Earth Smarts model. Whilst the Museums, Libraries and Archives Council's Generic Learning Outcomes framework has been useful for the pilot study, it rendered many specific social skills hard to categorise between the domains of behaviour and skills. A modified survey activity with open-ended responses within clear categories will be used. Having assessed ideas hermeneutically for the pilot stage, enough information about the range and scope has been gathered to narrow down the activities to specific questions.

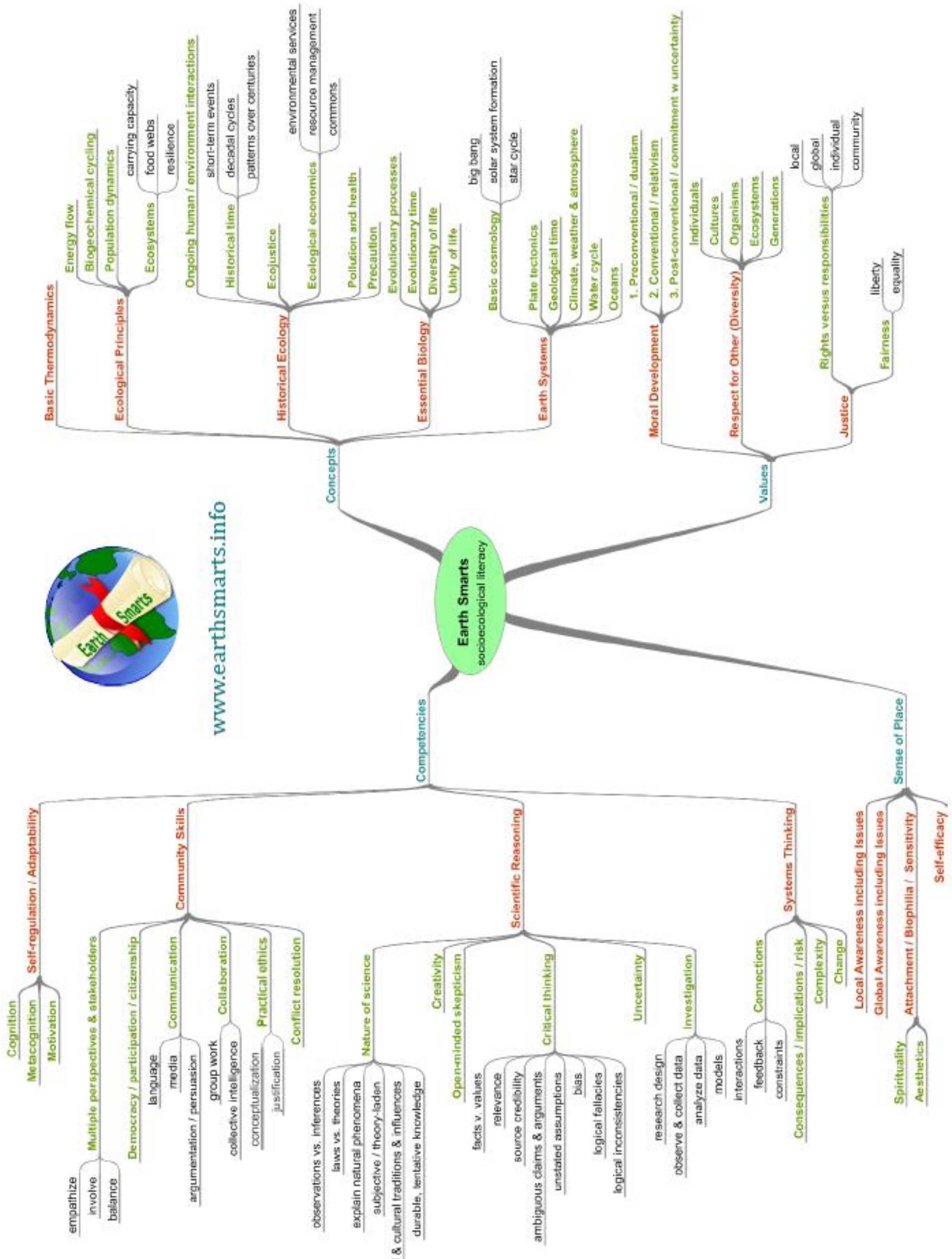


Figure 3.20 Domains in the Earth Smarts model (Nichols and Zeidler, 2012), which is the key framework for analysing data in this thesis

In addition, rather than comparing grouped pre-visit responses with grouped post-visit responses, observed individual differences in responses mean that I need to examine individual progression. According to Boeve de Pauw (2011), responses to the natural world can be affected by gender, socioeconomic factors and schooling;

therefore, in the main data collection I will use individual analysis methods (Jensen and Wagoner, 2011). This means that the difference between what each individual knew before and after will be investigated for analysis, instead of the differences seen within groups, before and after a visit to an informal science setting.

Unique aspects of learning

Rickinson et al. (2004) identified a gap in the research about taking advantage of the uniqueness of different outdoor science settings. It follows that taking advantage of both the similarities and the differences in settings is the basis for complementarity; amidst similar learning progressions and pedagogy, authentic aspects of each type of experience can be highlighted.

Environment Exploration

The cyclical model of expertise amongst peers (Ash, 2008) is appropriate for the environmental education model, where the uniqueness of the setting lies in the authenticity of seeing wildlife; it is a genuine situation where the teacher has not selected the order and position of real things. Children commented on the unfairness of the situation, as it is down to luck as to who gets to see the wildlife, although quietness and patience are promoting factors. The children who do not often get social kudos in the playground may be favoured by environmental experiences as they are more likely to see wildlife for real, and become the expert who cascades information amongst peers. The role of social interaction is becoming established; for example, Braund and Reiss (2004) explain the importance of social development on field trips for pupils aged 11-14. Gayford (1996) found that teachers, students and senior management recognised improvement in interpersonal skills as a major outcome of an environmental sustainability project where students were able to shape their school grounds and develop personal agency around decision making. One unexpected outcome of this project was a senior member of staff commenting to the effect that the degree of perceived control over relationships and surroundings could carry the risk of pupils being at odds with the status quo of the school, which had to impose order to an extent. There was evidence of pupils asserting their own views within the environmental exploration session during the pilot study, e.g. saying to an adult helper “you should have let us look at that for longer” which resulted in disagreement. This relates to the Values current of environmental education, explained in Chapter 2. Stevenson (2007) describes a tension between the formal education sector and environmental education, because of a requirement to structure and assess lesson content in formal settings. Gruenewald and Smith (2007) and Harding et al. (2010) explore these ideas in proposing the Earth Charter as a means to allow pupils to explore and assert viewpoints within lesson structures, making use of pedagogies that facilitate evidence collection and debate. The implications are that environmental exploration could be formally developed to allow exploration of values and viewpoints, to take a complementary role to the scientific investigative potential for natural history collections handling.

Natural History Specimen Handling

This research was initiated by recommendations for more ‘real learning’ by educators across a range of settings. Examining informal science educators’ contexts revealed that ‘real’ was assumed to mean outdoors, 3D, a specimen or alive by different people. The unique nature of the authenticity in each situation is the aspect that will allow learning to have additive effects such as those seen in this pilot study, where NH collections were associated with an increased ability to identify specimens (judged by using specimen names outdoors correctly, and the lack of knowledge-coded phrases such as ‘I don’t know what it is’). Children in Class 2 EENH showed greater knowledge of types of science. They showed greater self-report of scientific behaviours (observation, exploration, using equipment) as preferred ways to learn. Crucially, children who had taken part in the NH session had been given access to resources which allowed them to develop knowledge as a team, and largely independently of adults. They called to peers frequently in the subsequent environment exploration, but rarely to adults. When describing plants outdoors, they frequently mentioned texture, compared to Class 1 EE who referred only to colour. Therefore, the complementarity in sessions lies in allowing children to access resources so that they can become experts in identifying specimens when exploring. In this way, they will seek information from expert peers, and so provide opportunities for rehearsal and assimilation of knowledge. It was observed that the EENH group did not comment on their expectations about seeing nocturnal wildlife, because experience with specimens had given them more insight into the species it might be possible to see during the daytime.

A number of studies have examined the reasons why teachers do not take part in more fieldwork with their students. One aspect raised by this pilot study is that there is a threat to established authority, as authority can be transferred by chance to the keenest observers, who may well be those with eye levels closest to the ground. Milton et al. (1995) studied the experience of 46 primary pupils in a US park. University students taught field studies about ecology with the children. The authors found that the programme increased ecological knowledge and improved the social skills of the pupils. The researchers reported: “The process of developing teamwork through cooperative games and group projects … instilled in the children a sense of ownership and internalization of their knowledge of the park” (ibid., p. 32). Vaughan et al. (2003) found that parents in Costa Rica knew more about Scarlett macaws when their children had taken part in a teaching session about these birds. Teaching was passed on with children in the role of experts, through discussion – in this case around a homework activity.

When children share information with other children and adults, the roles of teacher and student cycle between peers and elders as information is gained and cemented through being passed on. An important motivating factor of environmental education seems to be the surprise and delight that the wildlife has almost ‘chosen’ them to be closest to the centre of the action, to make the first hand observations about what it looks like and how it moves, and to have a story to tell. Figure 3.21

presents a diagram to explain the complementary relationship between natural history collections and environment exploration, based on evidence gathered in this pilot study.

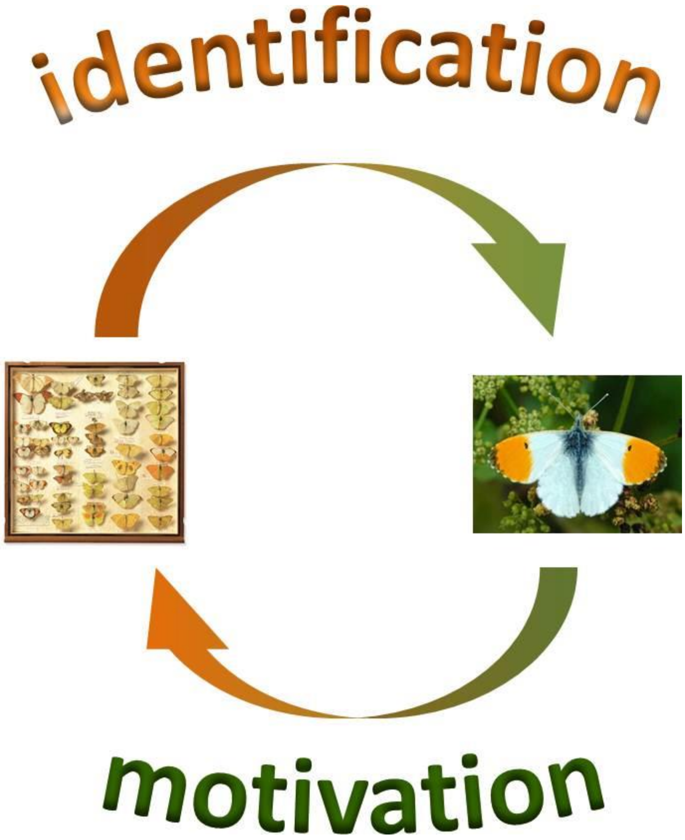


Figure 3.21 The complementary relationship between environment exploration and natural history specimen handling, for pupils age 9, revealed in the pilot study.

Conclusion

The pilot study presented a first stage in answering the thesis' research question: What do children learn about biodiversity in informal settings?

There is agreement that understanding components of ecosystems is vital for pupils in forming views that living things are interdependent. Both environment explorations and natural history handling sessions have the potential to develop pupils' understanding about interdependence in the natural world. Historically, environment education has links with a scientific inquiry approach. Specimen handling has arisen from scientific examination of collections. The pilot study compared environmental exploration alone with a combined session that also included specimen handling. This initial study showed some evidence that environment exploration provided motivation for authentic discovery while specimen handling developed pupils' abilities to identify specimens. Pupils were surprised by the concept of humans as nature, which is consistent with the fact that this perspective of inter-relationship is not clearly present in the English primary curriculum. Results were triangulated to gather evidence in the GLO domains of knowledge, skills, enjoyment, activity and attitudes. Socio-cultural learning was apparent, but did not fit the analysis framework chosen. Therefore, methods have been revised and a new socio-ecological framework, based on Earth Smarts (Nichols and Zeidler, 2012) will be used for the main data analysis section of this thesis.

3.7 Settings

The three examples of informal biodiversity settings were chosen because they met the criteria for answering the research questions, and for practical considerations to do with access for schools. A major barrier to schools being able to take part in informal education is the cost of transport. Following the conclusion from the pilot study, I worked with schools in close proximity to each other, to maximise the likelihood that children would come from similar catchment areas.

In addition, I was particularly interested in working with children from culturally diverse backgrounds in an urban area, because they represent a typical visitor to venues I had taught in, and their needs in terms of learning content are a gap in the research. Using the criteria of diverse pupils, urban areas and proximity to a natural specimen collection and environment centre, I selected the area close to King's Cross, London as the geographical area in which to conduct research.

3.7.1 Environment Exploration

I identified London Wildlife Trust's Camley Street Natural Park as a site in close proximity to King's Cross and that runs biodiversity workshops for primary pupils. Camley Street hosts a similar number of school visits as the Royal Veterinary College Museum. I contacted Phil Paulo from the London Wildlife Trust (who manages the site), and was put in touch with Helen Burton, Education Officer. I had a meeting about the workshops d research. I received agreement to proceed with research and was put in contact with teachers to approach for classes of research participants. From observation and session plans, a typical workshop involves an introduction to the site from education officers, then three activities for groups to take part in: an environment exploration walk, pond dipping, and making seed balls for birds. It concludes with a plenary about food webs.

3.7.2 Live Animal Shows

I chose to work with Animal Man Ltd., a company that provides live animal shows to schools. I opted to take the live animals to the school rather than asking the school to visit a zoo, owing to the costs and transport involved. In addition, this is advantageous for combined sessions that research learning when children take part in more than one experience, because the live animals could be taken to the RVC or Camley Street to minimise travel time for pupils. I had a meeting with Stuart Short from Animal Man Ltd., and received agreement to proceed with the research. Animal Man Ltd. own a range of animals and visit schools and parties. The regular session for year 4 pupils addresses habitats and adaptations. It takes the format of an introduction, followed by animals being described and discussed in an interactive session where volunteer pupils are called to the front to handle the animals.

3.7.3 Natural History (NH) Specimen Collection

I approached the Royal Veterinary College (RVC) Museum, King's Cross, London as an example of a natural specimen collection. I contacted James Cannon, Access and Education Officer at the College, for access to the collection and a better understanding of the existing education programme. In addition to training veterinary students, the organisation's specimen collection, in their museum, is used for school groups. RVC runs a programme about habitats and adaptation for Year 4, which matches the curriculum objectives being researched in this thesis. After a meeting with James Cannon I received agreement to proceed with research using the RVC habitats and adaptation sessions as an example of the specimen collection setting. This brings a caveat to the research, as the veterinary collection is extensive but has a veterinary teaching purpose as opposed to a taxonomical purpose as in many Natural History collections. The RVC Museum hosts approximately five thousand pupils per year on visits to the collection, and at later ages to see live animals. The sessions at the museum are funded by the Royal Veterinary College. From observation and looking at their session plans, the typical session format involves an introduction to the space and the collection, followed by free exploration of the museum collection, guided by a worksheet asking pupils to look for evidence about the adaptations that species have for where they live and what they eat. Some specimens can be handled. The session concludes with a plenary, reviewing pupils' learning. James Cannon agreed to share my details with existing school contacts, who were within walking distance of RVC and aware of the existing sessions.

The three settings listed above build on the work started in the pilot study. Research in the Natural History Museum Wildlife Garden was a basis for understanding the learning which might take place in an environment centre such as Camley Street Natural Park. Research in the Natural History Museum with an object handling collection was a basis for understanding children's learning when looking at and handling natural specimens in the Royal Veterinary College Museum. (Live animal shows were not used in the pilot study, because the pilot study was intended to have a smaller scope than the main data collection.)

3.8 Recruiting school pupil participants

In order to recruit schools, the same procedure was followed for each school. An email with an advertisement about the research explained that it would involve a free session for pupils about habitats and adaptation, and asked teachers to select available dates. Following selection based on location (see Figure 3.22) and email contact, I telephoned teachers to discuss the research, and to seek agreement in writing to proceed. I explained the need for pre- and post-visit sessions. I then emailed consent forms for pupils, which explained the research. These forms asked for parents' permission for their children to attend the trip and, separately, requested permission to collect written, still image and video data (see the Section on ethics below). I asked teachers to collect the responses, and personally collected the forms prior to the pre-visit session.

The same procedure was followed for all school participants. In each school, approximately thirty year 4 pupils took part. Five primary schools took part in the research, with locations shown in Figure 3.22. All participants were year 4 pupils, and were between 8 and 9 years of age.

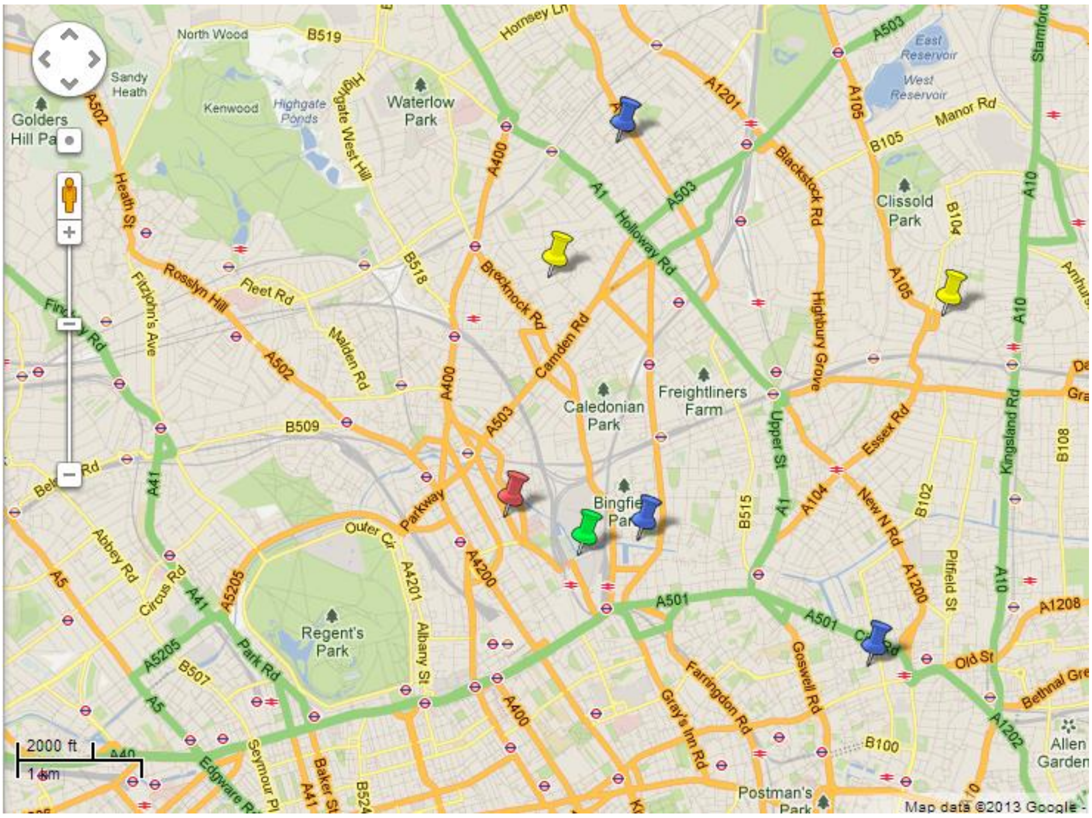


Figure 3.22 Location of research participants, located in London, UK. Red pin – Royal Veterinary College; green pin – LWT Camley Street Natural Park; yellow pins – schools that took part in single visit experiences; blue pins – schools that took part in combined visit experiences

The schools were selected for having similar demographics in terms of catchment area and Ofsted results. Schools were all located in the urban local authorities of Camden (average 40.5% free schools school meal (FSM) eligibility prior to universal FSMs) and Islington (average 47.5% FSM). Pupils who speak English as a second language varied from 42.5% - 61.8%, which would place this sample as a culturally diverse group of pupils. The average percentage of pupils achieving level 4 or above in Year 6 SATS in the sample was 70.4%, and Ofsted reports were 'Good' for all schools apart from one school which was graded 'Satisfactory'.

3.9 Research Procedures

3.9.1. Pre- and post-visit activity

Pre- and post-tests are established methods of quantitative research (Creswell, 2011). The activity designed for this research uses open-ended questions, meaning that the data are qualitative (Dillon and Wals, 2006), but in assigning a score data become quantitative. A drawback with this design is that the responses take longer than other methods to analyse; however, I felt that this time investment was justified given the richness of information it could yield. Pupils undertook a pre-visit activity as shown in Figures 3.23a and 3.23b. The activity had been modified from the pilot sessions. Initially in the pilot sessions I had asked pupils to complete pre- and post-visit mind maps. Analysing these mind maps had identified themes of pupil understanding about species, and had given insights about their understanding of the Earth Smarts domains of Concepts, Sense of Place, Values and Competencies. Having used the pilot study to develop my understanding of the potential range of responses, I redesigned the activity, and included the context of a 'Zooseum' to make it seem more like an activity than a test. The context was that children would have to explain what they would show someone about animals in a zoo or museum, which experience and pedagogical training led me to believe would be more enjoyable and produce richer data. After all, if you ask a child to report what they learnt, you generally receive a terser answer than when you ask them to imagine explaining to a younger child what they have done.

Figure 3.23 shows both sides of a pre-visit activity sheet. The instructions included asking children to write any additional languages they spoke at the top of the paper. This was because many children spoke English as an additional language, and collecting this information allowed identification of any considerations that needed to be taken into account for children with diverse backgrounds. As previously stated, the relationship between language and learning about biodiversity informally, in London, appears to be a gap in the literature.

Question 1 'Which animals and plants do you know about? Write their names or draw' sought to understand the breadth of children's knowledge of species, from a factual point of view. Based on the pilot study and literature review, I wanted to understand children's conceptions of local and world species. I explained the meaning of the word 'local', and told children that some animals and plants could be in both boxes. To an adult it might make sense to draw this question as a Venn diagram, but for children aged 8 this would have complicated the activity and taken the focus away from the most important data.

Question 2 aimed to probe children's depth of understanding about animal features. The prompt questions below it are based on knowledge of the curriculum and understanding of the range of likely responses (from my teaching experience and the pilot study responses). Children were asked to add to the diagram to show what they would like to explain about one type of animal.

Question 3 aimed to understand the range of informal learning experiences that children have previously undertaken, and to check validity by checking that they reported having visited the experience that was being tested by the experimental design.

Question 4 aimed to address the domain of 'place' by asking children 'Is there a natural place or an outdoor space you particularly like?'. They were asked to circle YES or NO, and then to draw or write about it. The aim of this was to understand children's attachment to natural spaces, and to investigate the effect of visiting an informal biodiversity place with respect to attachment to place.

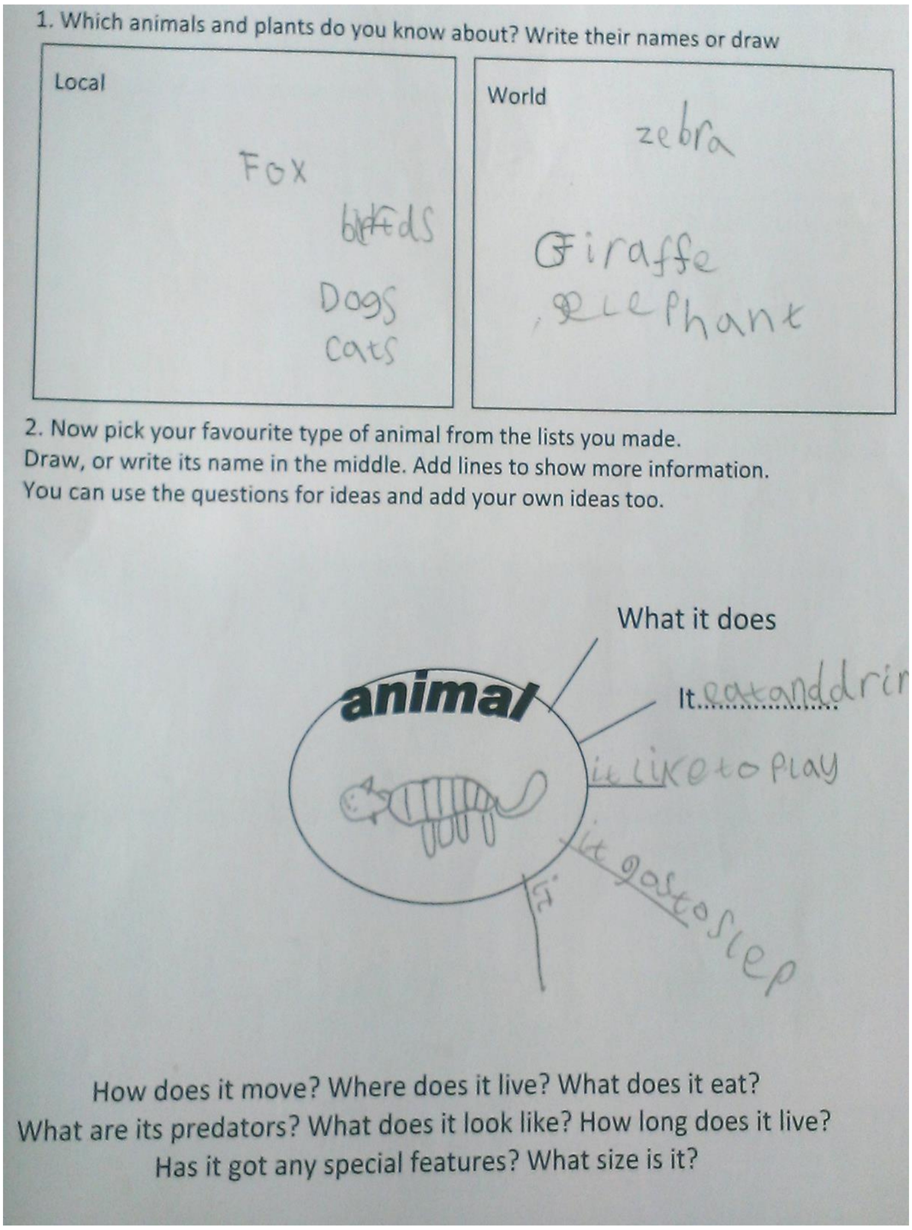
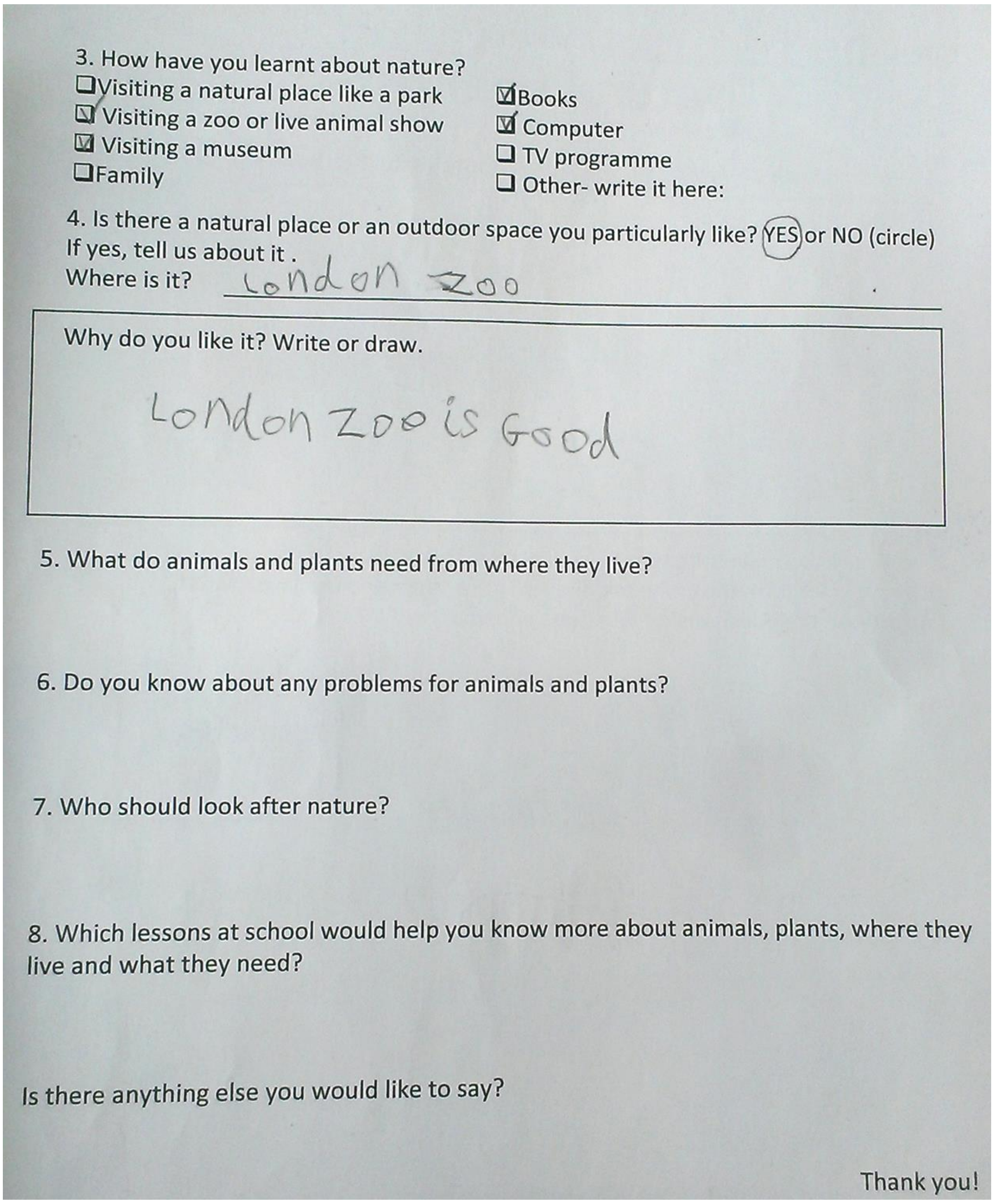


Figure 3.23a Pre-visit activity ‘Zooseum’ side 1. This was carried out as a pre-visit activity for all six classes that took part in the main data collection, a day prior to their visit to a biodiversity learning experience.

Questions 5 ‘What do animals and plants need from where they live?’ and 6 ‘Do you know about any problems for animals and plants?’ could be included as factual knowledge if one believes that there are unambiguously correct answers to these questions. They are intended to better understand children’s range of responses, ranging from personal experience to broad worldviews; they therefore could be argued to belong to the ‘attitudes’ domain of learning. Questions 7 ’Who should look after nature?’ and 8 ‘Which lessons at school would help you know more about animals, plants, where they live and what they need?’ aim to understand attitudes to nature. They are inspired by reading literature in the field of ecoliteracy, for example Sauvé (2005).



3. How have you learnt about nature?

- ☐ Visiting a natural place like a park
- ☑ Visiting a zoo or live animal show
- ☑ Visiting a museum
- ☐ Family
- ☑ Books
- ☑ Computer
- ☐ TV programme
- ☐ Other- write it here:

4. Is there a natural place or an outdoor space you particularly like? YES or NO (circle)
If yes, tell us about it .
Where is it? London Zoo

Why do you like it? Write or draw.

London Zoo is Good

5. What do animals and plants need from where they live?

6. Do you know about any problems for animals and plants?

7. Who should look after nature?

8. Which lessons at school would help you know more about animals, plants, where they live and what they need?

Is there anything else you would like to say?

Thank you!

Figure 3.23b Pre-visit activity ‘Zooseum’ side 2. This was carried out as a pre-visit activity for all six classes that took part in the main data collection, a day prior to their visit to a biodiversity learning experience.

At the start of the week when pupils were visiting biodiversity settings, I visited their class. Pupils listened to an oral explanation of the purpose and procedures of the research and were given the chance to ask any questions. They were subsequently given the pre-visit activity. I circulated around the class whilst pupils were completing the activity, to clarify any operational misconceptions. The whole procedure lasted 45 minutes with 30 minutes allowed to complete the questionnaires. For the post-visit activity, I repeated the activity at the end of the week in which pupils had experienced an informal biodiversity session or combined session.

3.9.2 Video recording

During each visit, I recorded twenty minutes video from a boy's perspective, twenty minutes from a girl's perspective and twenty minutes using a wide angle view. Each time, pupils were selected at random. Therefore, there was one hour's recording for each day. The hardware used was Looxcis video cameras, chosen because they are worn at eye level and show what pupils are looking at. In addition, they are clearly 'recording' as shown by a red light, illustrated by the girl on the right in Figure 3.24. The red light is shown underneath the white arrow.

Figure 3.24 The girl on the right is wearing a headset camera

3.9.3 Interviews

I compiled a set of semi-structured interview questions designed to gauge learning, using the Earth Smarts domains as a basis – see the analysis section 3.11 below. I undertook interviews with three pupils from each school, chosen at random. The interviews were video recorded and took place in school, immediately following the post-visit activity session. They each lasted approximately seven minutes.

At this time I also interviewed the class teachers using a semi-structured interview format, asking for their opinions about pupil learning, using the Earth Smarts domains as a starting point. Each interview lasted approximately ten minutes. All interviews were transcribed fully, and each comment was written up as a paragraph. Comments from interviews are used as evidence in Chapter 6. Interview comments are presented on a still image from the interview footage at the point that the phrase was uttered in a speech bubble next to the interviewee. Whilst this mode of visualising interviews is novel for a thesis, it is intended to capture the richness of the interview process.

3.10 Ethical considerations

I obtained permission to carry out the research, from the Institute of Education Faculty Research Ethics Committee. Of particular consideration was the need for parental approval for video recording of pupils, which was obtained via a trip consent letter (Isreal and Hay, 2006). In addition, I asked teachers to make sure I was aware who was allowed to be filmed. Film is stored in compliance with the Data Protection Act 1998. Photo permission was obtained for all images shown in this thesis.

I returned to classes and presented back to pupils a summarised version of their results, at the same time as thanking them for participating. All parents and children who took part were invited to an event at Camley Street Natural Park on July 6th 2012, as part of the initiative 'Empty Classroom Day'.

3.11 Analysis

The analysis introduced in this Section draws upon lessons learnt from the pilot study. Instead of using the Museums, Libraries and Archives framework (see Chapter 4) as a basis for coding, an alternative framework will be used, for reasons described in Chapter 4. This is Nichols and Zeidler's (2012) Earth Smarts Socioecological literacy framework, shown in summary in Figure 3.25.

By socioecological literacy, Nichols is referring to the understanding that people need to interact with their environment and others in order to live sustainably and thrive. The importance of continued wellbeing in challenging times for natural resources was a driver for using this framework, particularly when traditional ecological awareness does not always get passed on between generations in urban settings. The framework aims to be practical, theoretically grounded, nonpartisan and flexible. The premise of this framework is that we are living in a changing society and environment, with increasing pressure on resources. Humans need to be able to adapt within this increasingly urban, crowded and technological context. Young people need to be able to plan and shape this context in future. The framework was based on an extensive literature review but, crucially, then involved a collaborative process to agree the domains in which people need to have understanding to be socioecologically literate. Figure 3.25 shows the four main areas of understanding, called domains.

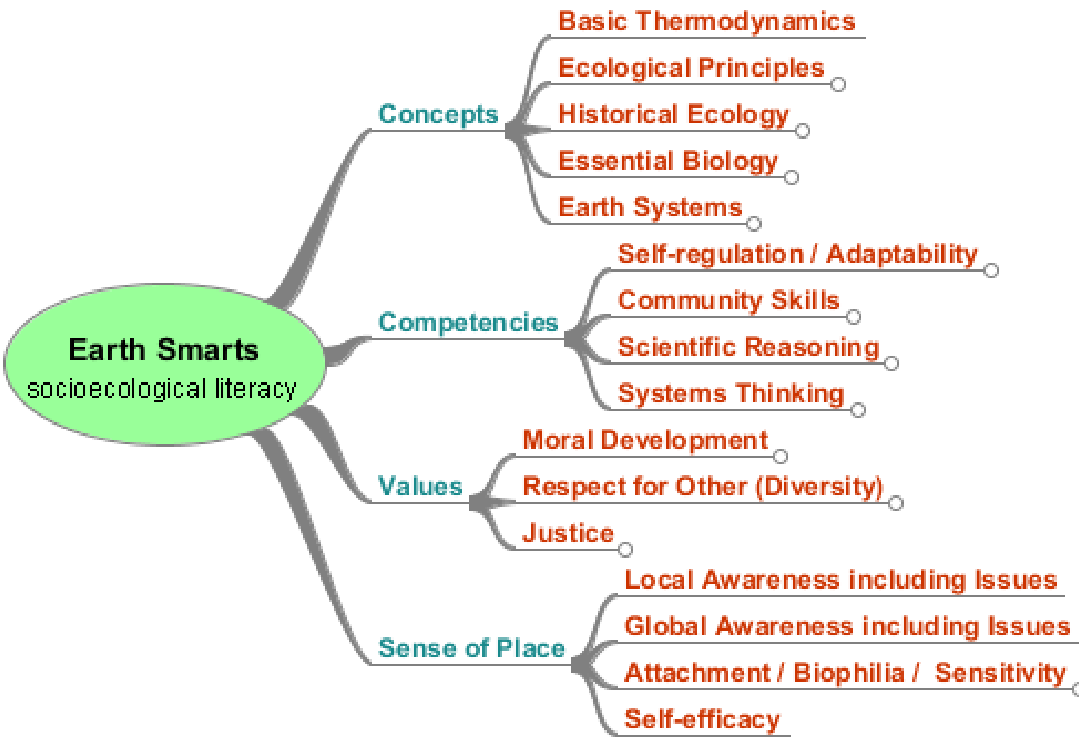


Figure 3.25 Earth Smarts socioecological literacy domains (Nichols and Zeidler, 2012)

This framework was extended through stakeholder consultation to achieve consensus on socioecological literacy. *Concepts* can be correlated with the MLA and curriculum domain knowledge. *Sense of Place* is specific to the Earth Smarts framework. *Values* can be correlated with the MLA framework directly, but additionally the subdomains are specified with direct relevance to socioecological literacy, highly relevant to this study. *Competencies* can be correlated with curricular and MLA framework domains of skills. I was interested in the subdomain of community skills which are articulated clearly in Earth Smarts as shown in Figure 3.26.

Figure 3.26 Community skills in the domain 'Competencies' within the Earth Smarts Framework

This Earth Smarts framework was chosen as a basis for analysis after careful consideration of data that did not fit the Museums, Libraries and Archives framework used in the pilot study. These data particularly included aspects relating to community skills, which the Earth Smarts framework elucidates clearly.

For coding, the Earth Smarts framework (Nichols and Zeidler, 2012) will be modified and reduced to categories that are appropriate for pupils age 8 and 9. I am basing this selection of appropriate categories on my experience of teaching as a Year 4 class teacher and being an education manager and Natural History Museum Learning Programme developer. The aspects that are relevant to this study and appropriate for Year 4 pupils are now discussed under four sub-headings.

3.11.1 Earth Smarts Domain: Concepts (knowledge, content)

Ecological principles: English Year 4 pupils are starting to study feeding relationships, in preparation for further work on life cycles in Year 5 and food webs in Year 6.

Historical ecology: This area includes the interaction between humans and the environment, ecojustice and the influence of society on the natural world. At Year 4, children would be expected to understand aspects of pollution and recycling.

Essential biology: The concept of essential biology includes an understanding of common and diverse elements of physiology, within and between species. This is highly relevant for year 4 pupils' formal science work. A classic example for Year 4 science would be to understand variety in adaptation by relating thick fur and white camouflage on a polar bear for survival advantages of thermoregulation and successful predation on herbivores. At the time of starting this study, understanding evolutionary timescales was not part of the science curriculum for the participant age group. However, at the time of writing curriculum reform means that evolution will be taught much earlier in the curriculum, and therefore children aged 10 will be expected to understand aspects of evolution.

Earth systems: Adaptation to weather and climate are part of the understanding that would be covered at year 4 in England.

Evidence for children's learning in this domain will be gathered through pre- and post-visit activities.

3.11.2 Earth Smarts Domain: Competencies (skills, abilities)

Self-regulation / adaptability: This category refers to the ability to keep learning.

Community skills: Nichols includes democratic participation, argumentation, collaboration and collective intelligence, practical ethics, communication, conflict resolution and the ability to consider multiple perspectives and stakeholders as community skills. One of the main reasons I selected this framework is the fact that it acknowledges the need for teamwork of this nature, and I will be assessing evidence of these skills through video data. These are covered in the curriculum in

England through personal, social and health education to an extent, but I felt they were stated with clarity in this framework.

Scientific reasoning: Scientific reasoning skills include understanding the nature of science. These skills in asking questions, suggesting, gathering evidence, and critical thinking are central to the nature of science. They equate to scientific enquiry skills in the formal curriculum in England.

Systems thinking: Nichols states that systems thinking (understanding connections and interactions) is increasingly important in our complex society in order to understand consequences and risk. It is also significant in terms of flexibly using and producing information.

Evidence for skill development will be gathered through video data.

3.11.3 Earth Smarts Domain: Values (ethics)

Moral development: Moral development allows an individual to sustain their mode of life without compromising that of others. Nichols considers that moral development should allow adults to make choices that are beyond children's binary right/wrong categorisations. At the level of year 4, moral awareness may be seen as questioning the actions of others, or backing up a point of view.

Justice: This refers to the balance between individual rights and community responsibilities. At the level of year 4, this would be seen in examples of awareness of actions one person can take which benefit others.

Respect for others: Respect for others includes other cultures, organisms, ecosystems and generations. Examples would include understanding that different groups view the environment differently, and use resources differently. Children would respect diverse species; at age 8 they are unlikely to appreciate the wealth of scientific insights that different species can lend, but they would have positive views towards a range of species. They would be aware that there are other ecosystems. They may have learnt stories from their family which develop their respect for nature.

This domain will be researched through pre and post-visit activities; asking children who should look after nature will give insight into their views. In addition, video evidence and interviews will give information through conversations.

3.11.4 Earth Smarts Domain: Sense of Place (awareness, affect, emotions)

This includes awareness of local community including issues: are children aware of their immediate locality? Nichols asserts that many people are unaware of their immediate surroundings. It also encompasses awareness of global community including issues: are children aware of nature around the world? What do they know about problems for living things? Themes of biophilia (Wilson, 1984) i.e. an emotional bond with nature and sensitivity to the environment, are included in this domain.

Drawing on the ecoliteracy literature, Nichols states:

> Whatever you call it, an attachment to the land is important – we need to care about our communities and environments, both local and global. This connection may be some combination of spiritual, religious and aesthetic factors, and culture obviously plays a huge role. Many modern education systems do not address this well at all, sealing children in "safe", sterile classrooms for their entire development.
>
> (www.earthsmarts.info, accessed March 2012)

Understanding of place is addressed to a certain extent in Geography in the curriculum in England, although many primary schools have moved away from a disciplinary approach and are instead using a creative curriculum; therefore, the extent to which this is covered will vary considerably between schools. The English curriculum does not cover the emotional aspect of developing a bond with a place.

Self-efficacy: Are children aware of how they can make a difference? Evidence will be gathered through pre- and post-visit activities.

Where additional categories arise from the data, I will add them to the framework and review data for these new categories. Raven (2008) advocates the importance of reflexivity in choice of methodological framework for developing effective educational research practices. She notes evolution of her own conception of categories in which to assign data during the research process, and it is this approach that I intend to draw on. Flexibility and review are particularly important for analysis when integrating qualitative and quantitative data (Bryan, 2007). I intend that, through analysis, a conceptual understanding of learning that has taken place in three settings will be achieved. This will be used as a basis for discussion, comparing children's learning with the wider aims of environmental education.

The next chapter presents the results obtained using the mixed methods and conceptual analysis framework described in this chapter.

Chapter 4 Results

4.1 Introduction to results

This chapter presents key findings from data collection, showing how pre- and post-visit information and video data have been collectively analysed to answer the thesis question: *What do children learn about biodiversity in informal learning settings?*

As a result of data analysis, a version of the 'Earth Smarts' framework (Nichols and Zeidler, 2012) has been modified to form a new conceptualisation of children's learning that results from informal biodiversity education. The acronym for this conceptualisation is 'SPEAK', representing different domains of learning: Skills, Place, Emotion, Attitudes and Knowledge. Data are presented under these headings in the chapter Sections 5.2-5.7.

In order to understand the following results, it is necessary to explain the codes that have been used in conceptualising children's learning. They are shown in Figure 4.1. These are the concepts that children learnt about biodiversity in the three informal settings. Some were modified from the Earth Smarts framework (Nichols and Zeidler, 2012), whereas others arose through analysing pre- and post-visit activities and video data. This results chapter will show that the three different settings investigated conveyed these concepts to different extents. The elucidation of these codes is of central importance to this thesis; therefore, the decision has been taken to explain each code in detail. In Figure 4.1 they are grouped by domain, in alphabetical order.

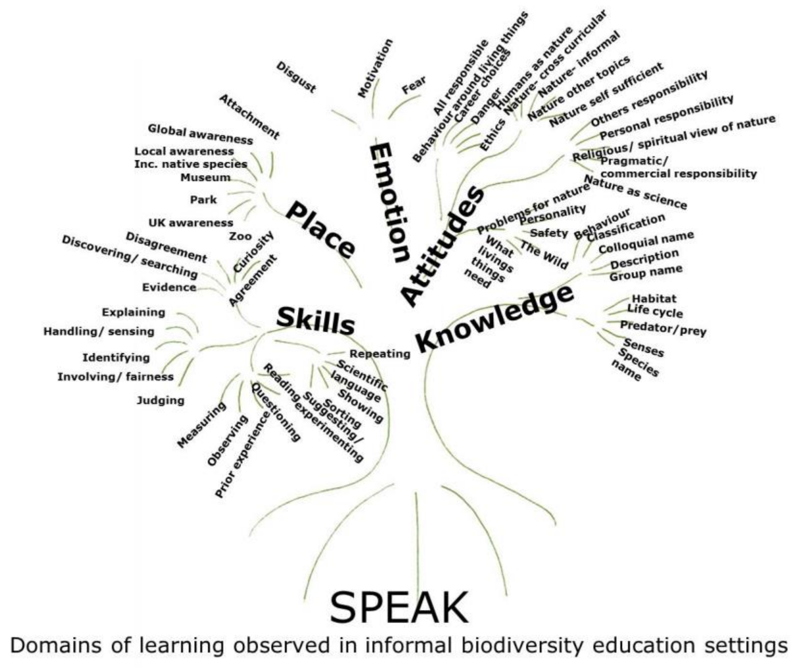


Figure 4.1 SPEAK conceptualisation, showing learning observed in three informal biodiversity settings. The branches of the tree show codes which were used for data analysis.

In the curriculum in England the key statutory areas are in the domains of skills and knowledge, whereas in some other countries' curricula (for example, the Te Whariki curriculum in New Zealand), attitudes are explicitly mentioned in curricular guidance. Therefore, in England there is a split between formal learning (which focuses more on traditional learning domains) and informal learning, where there is scope for focussing on emotions and attitudes as learning objectives. The findings of this research show evidence both of domains which are covered by the formal school curriculum – skills and knowledge – and of domains which are relevant to informal education settings – understanding of place, developing attitudes and emotional responses.

4.1.1 Evidence for children's informal learning about biodiversity

Evidence for learning was in the form of written and drawn data (from pre-/post-visit activities), video footage from children's headset cameras and video interviews with pupils. Additional sources of qualitative information emerged throughout the study. The first was an extension activity, which asked children 'What happened today? What did you think about it?', leaving a blank space for them to write or draw. Gellert (1962) was the first to use drawings as a means of researching science education, and this method has subsequently been used by a number of researchers, for example Reiss et al. (2007). The extension activity was used after children had finished their post-visit activity, but there was still lesson time remaining. In addition, some teachers asked pupils to write accounts of their experience, and assessed them. Some teachers asked pupils to write thank you letters. Such activities were not carried out equally across all classes and therefore cannot be analysed in the same way that planned data collection evidence was. However, where they help to illustrate a point, I have used them here to provide detail. Therefore, drawings will be used occasionally to illustrate points which arise from the quantitative data. At each stage, further areas for research are suggested where appropriate.

4.1.2 Results overview

Results were analysed by coding both pre- and post-visit data (which showed evidence of development in attitudes, knowledge and place) together with video data (key evidence for skills and emotion). Post-visit interview data have been used as a source of qualitative comments from interviewees, which extend understanding of the other data, and are presented both in this chapter and in the discussion (Chapter 5).

The existing framework for analysis, based on Earth Smarts (Nichols and Zeidler, 2012) was modified as new themes emerged, as shown in Figure 4.2a and 4.2b.

	Code	Tally	Examples
Concepts	Group name		
	Species name		
	Eats		
	Description		
	Habitat		
	Life cycle		
Values	Ethical questions		
	Respect for variation		
	Personal responsibility towards living things		
	Others responsibility towards living things		
	Religious view of nature		
	Spiritual view of nature		
	Pragmatic/ commerical view of nature		
	Fairness		
Sense of Place	Ability to change a location		
	Attachment		
	Local awareness		
	Global awareness		
Competencies (video data)	Observation		
	Uncertainty		
	Using evidence		
	Creativity		
	What science is		
	Involving		
	Agreement		
	Use of specific language		
	Disagreement		
	Motivation		
	Community skills (showing, explaining)		

Figure 4.2a An initial analysis coding chart, which was modified in the iteration shown in Figure 4.2b

	Code	Tally	Examples
Concept	Group name		
	Species name		
	Predator/prey		
	Description		
	Habitat		
	Life cycle		
	Senses		
	Behaviour		
	Classification		
	Colloquial name		
	Problems for nature		
	What livings things need		
Values	Ethical questions		
	Respect for variation		
	Personal responsibility towards living things		
	Others responsibility towards living things		
	Religious view of nature		
	Spiritual view of nature		
	Pragmatic/ commerical responsibility		
	All responsibility towards living things		
	Nature self sufficient		
	Fairness		
	View of nature as science		
	Nature as cross curricular		
	Nature as informal		
	Nature other topics		
Sense of Place	Ability to change a location		
	Attachment		
	Local awareness		
	Zoo		
	Park		
	Global awareness		
	UK awareness		
	Other		
Compet encies	Observation		
	Uncertainty		
	Using evidence		
	Creativity		
	What science is		
	Involving		
	Agreement		
	Use of specific language		
	Disagreement		
	Motivation		
	Community skills (showing, explaining)		
	Questioning		

Figure 4.2b A modified analysis coding chart; additional codes are included after having observed them in the data, such as in the domain 'concepts'.

The coding chart in Figure 4.2a has the initial codes which were identified when analysing data. A tally mark was made when evidence of the code was observed from either pre-/post-visit or video evidence. Evidence for learning was presumed to have occurred when relevant actions / speech was seen / heard only post-visit (i.e. pre-visit answers were 'subtracted' from post-visit data). The questions in post-visit activities had been chosen to provide evidence in the domains Concepts

(Knowledge), Values (Attitudes) and Sense of Place (Place). Evidence for Competencies (Skills) was seen in video evidence and in many cases there was not a tangible outcome; for example the code 'Observing'. The evidence for specific codes is explained in full detail below. In addition, the domain 'Emotion' was subsequently added as there was video evidence of pupils' emotional reactions to the sessions, which I wished to document. Therefore, the results below draw on both pre-/post-visit evidence and video evidence.

This Section provides an overview of the data over the different domains (Skills, Place, Emotions, Attitudes and Knowledge) summed together. Presenting the data from the three types of experience together provides evidence that biodiversity experiences do result in children's learning, which cannot be assumed to be the case. Therefore, this Section provides general support for the informal learning experiences in which the children engaged. It is intended to give the reader an overview of the overall relative frequencies of the learning codes, in preparation for examining the results in more detail in Sections 4.2-4.6.

4.1.3 Changes in children's learning after informal biodiversity visits

Figure 4.3 shows that knowledge of species names was the most frequently occurring code. As mentioned in the literature review (Chapter 2), Barker and Slingsby (1998) consider that knowledge of species names is the basis for understanding ecological relationships. Motivation (for example laughter, exclamations, hands up) was the next most frequently occurring code. The significance of each code will be considered in the following Sections. Seven out of the top twenty codes are in knowledge domains; knowledge is the domain which shows the most evidence of learning when one considers only the top twenty. This is also the case when all data are considered, as shown in Figure 4.4.

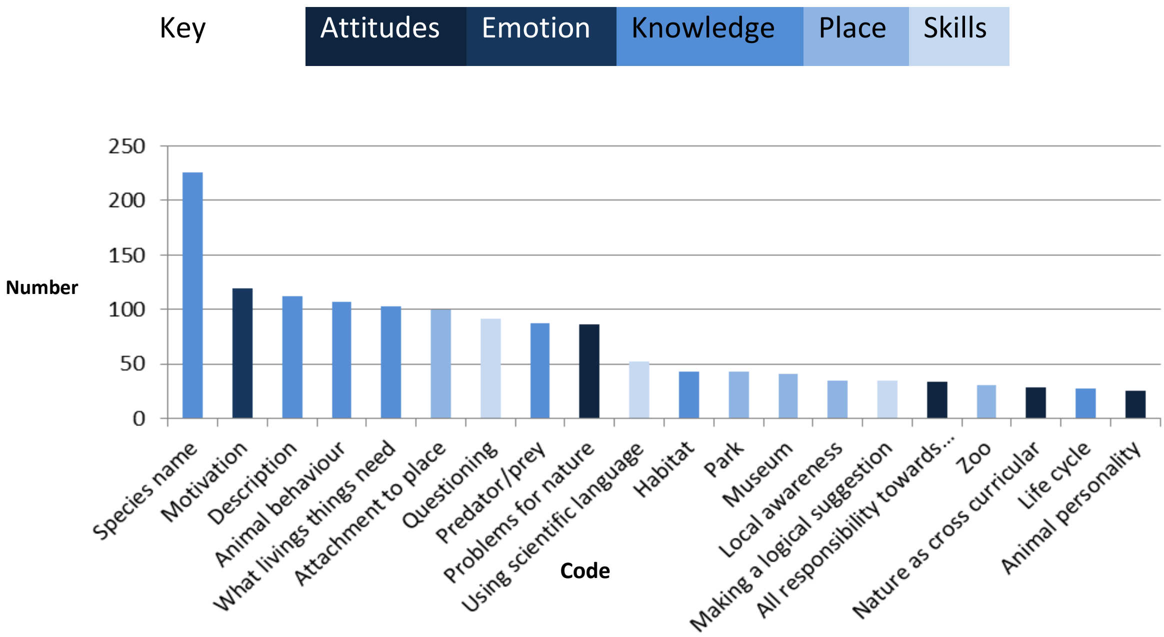


Figure 4.3 Twenty most frequently occurring codes – all data, from all six classes in the data collection sample. The colours of the bars refer to the learning domain under which each code has been classified. The y axis shows the number of times each code was observed

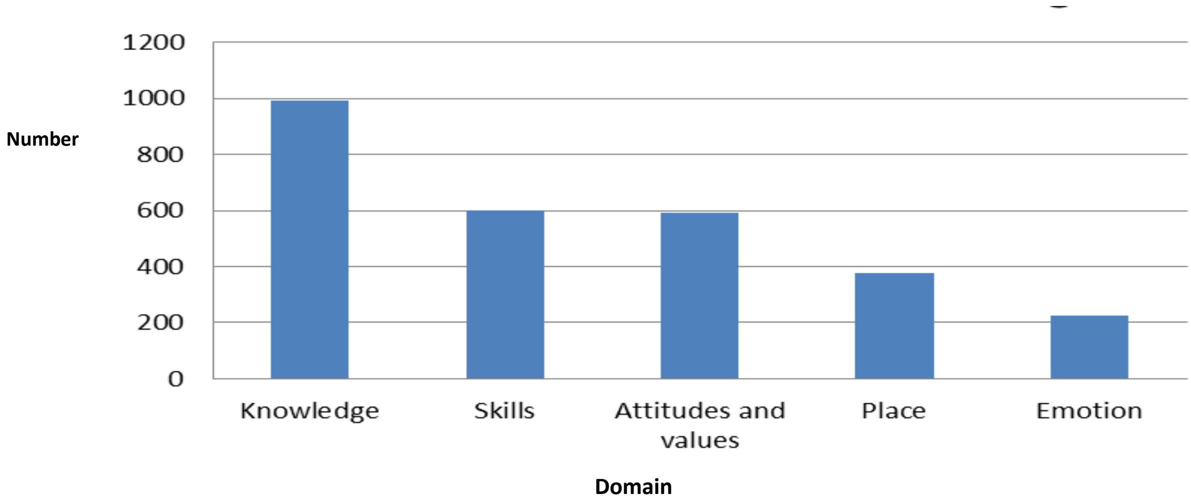


Figure 4.4 Distribution of all codes in all settings, using data from all six classes in the data collection sample. The y axis presents the total number of items of data observed (n = 1869) and the x axis shows each domain

Figure 4.4 shows that when every piece of evidence is considered, the domain for which the most data were found is knowledge. The difference in the number of codes observed for Skills and Attitudes was almost negligible (the domain 'Attitudes' also includes values in this case). The domains with the lowest numbers of codes were Place and Emotion, and these two domains are specified least by the National Curriculum in England. This evidence raises a question: do informal educators feel that they have to dedicate the majority of the time spent in informal learning sessions to traditional curriculum domains (knowledge and skills) in order to help teachers justify a visit? If so, is this the best use of the opportunities which informal learning experiences could potentially provide?

Figure 4.5 shows a child's drawing recalling her experience of visiting Camley Street Natural Park. According to visual culture theory (e.g. Kress and Van Leeuwen, 2001) the layout of the drawing is significant, whether it is object-centred or array-centred. The latter signifies that the relationships between the objects are of most importance. As shown below, the short narrative confirms that this is the case; the cat is shown following the pupils as they look at the hedge; aspects are realistic sizes (more likely when the objects are shown in relation to one another -Reiss et al., 2007). The small logs look like the woven wooden fence which is at a low level on parts of the woodland trail. The depiction of the cat is consistent with Luquet's (2001/1927) explanation that young primary children show intellectual realism rather than visual realism. To explain this, whereas an adult or teenager would draw what one viewpoint would see of the cat (which may mean one leg is hidden by another, or one only sees one eye for example), young children draw everything they know to be there, regardless of whether it can be seen by the viewer or not. Luquet terms this 'Rabattement' meaning folding out. It can be seen here in the legs of the cat; we see all four. The exceptions in Figure 4.5 are the feet of the short-haired person, which have been drawn as the viewer would see them. This drawing does show evidence of the effect of visual culture; the characters have a cartoon-like quality, with large eyes and eyelashes, for example. However, this drawing does not show evidence of awareness of scientific illustration at this age; for example there are no labels, and the roots of the trees are not shown. The significance of the choice of colour is unclear; it is unexpected that only one T-shirt is coloured green whereas the hedges are left uncoloured. Literature is inconclusive on children's use of colour in drawings (Kress and Van Leeuwen, 2001).

The significance of this drawing is that the most memorable part of the trip for this child was the experience of walking through the woodland trail, with the surprising element that the cat followed them.

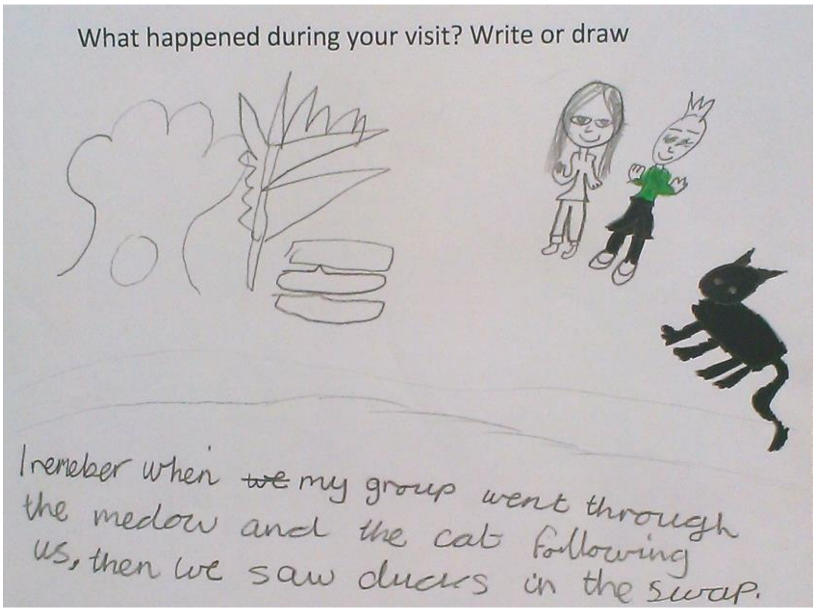


Figure 4.5 Child's drawing recalling a visit to Camley Street Natural Park. This source of information was supplementary to the main data collection methods; however, it has been included to add richness to the quantitative data.

4.1.4 Children's learning about biodiversity in different settings

Figure 4.6 shows that live animal shows resulted in the most attitudinal codes, likewise for knowledge and place codes. The distribution of evidence is similar across all settings; but it does vary. Environment explorations resulted in the most emotional codes. Natural history specimen handling resulted in the highest number of skills codes. In order to understand the effect of each setting better, data were compared using the calculation "total X setting minus total 'not X' setting", so as to isolate which codes appeared exclusively for individual settings. Results are presented in alphabetical order with Environment Exploration first.

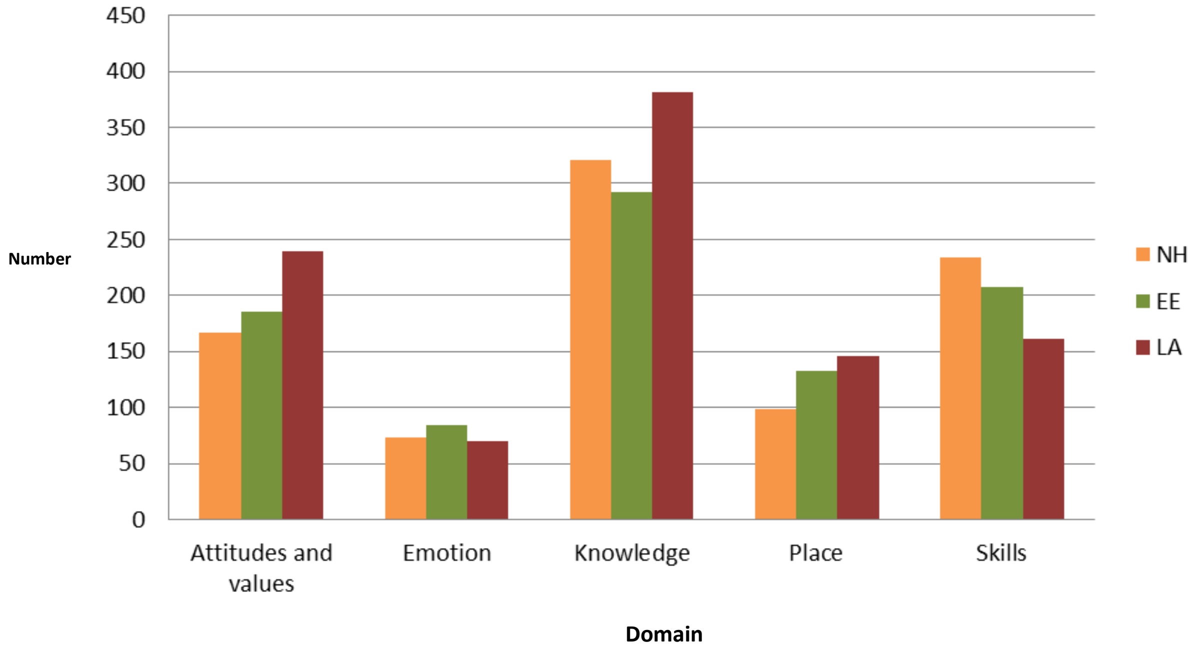


Figure 4.6 Distribution of all codes across domains, comparing different settings. This uses data from all participants. The y axis shows the total number of items of data observed for each domain, and the x axis shows the type of domain. Colours denote each type of setting, with orange = Natural History (NH), green = Environment Exploration (EE), and red = Live Animals (LA).

4.1.4.1 Environmental exploration

Figure 4.7 shows the most commonly occurring codes for the environment exploration sessions. ‘Motivation’ is the code which is most closely associated with environment exploration, followed by ‘questioning’ and ‘local awareness’. Each code will be described and considered fully in Sections 4.2-4.6.

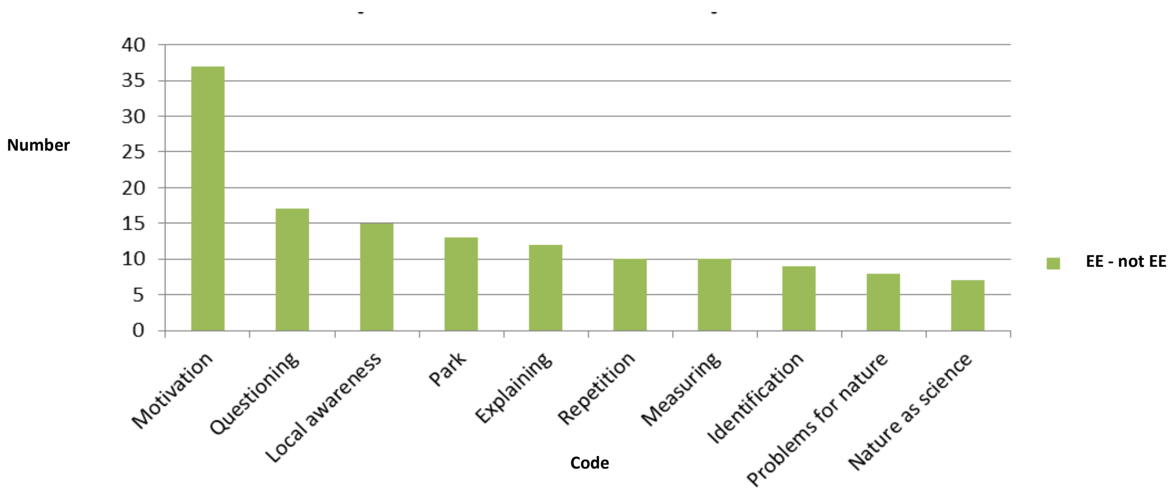


Figure 4.7 Top 10 Environment exploration codes. These data are from all participants. The y axis represents the difference in the number of responses in each coded category between classes that had taken part in an environment exploration and classes that had not. Results are arranged in order of decreasing difference.

Figure 4.8 shows another drawing representing environmental exploration. It shows awareness of a storyboard to communicate different aspects of the trip. This child has drawn all girls, smiling on their walk in the woods. In the second box in her clockwise storyboard-style drawing she has recalled using a thermometer, and shows children sitting down doing the hibernation activity. The fourth box has a caption showing evidence that she remembered the final aspect of the trip, which was placing producers and consumers in different areas on a panel display. Finally, she draws the tools needed to make a bird cake. There appears to be a lack of free choice “we had to ...”; however, the smiling faces and her comment below indicate that she enjoyed the activity nonetheless. It is clear that the memorable aspects of the trip for this child were the kinaesthetic elements, parts which involved movement. She has remembered walking, using a thermometer, going up to a panel and mixing ingredients. Looking at an experience in detail from one child's perspective brings insight into the memorable aspects of the visit.

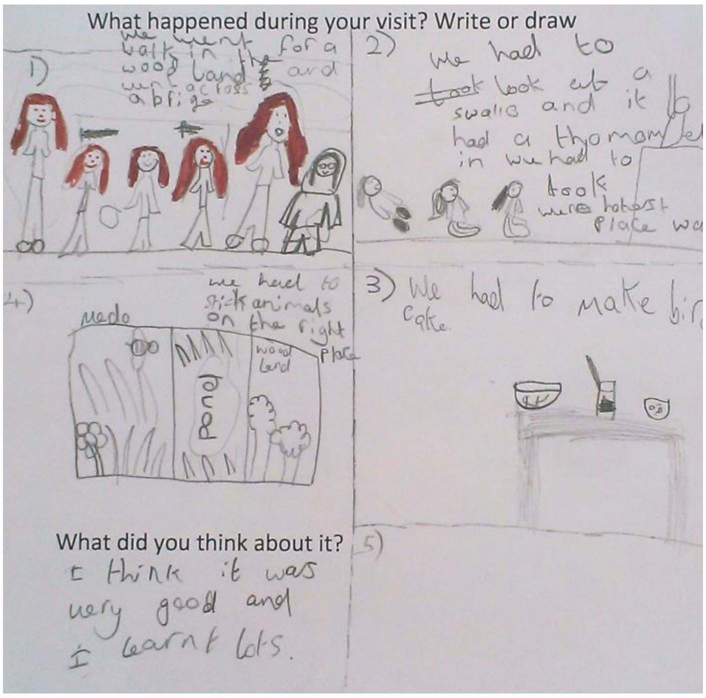


Figure 4.8 Drawing of an environmental exploration session in storyboard format.

4.1.4.2 Live animal shows

Figure 4.9 shows that 'description' is the code most closely associated with live animal shows, followed by 'personality' (evidence of children commenting on animal personality), then 'suggesting'.

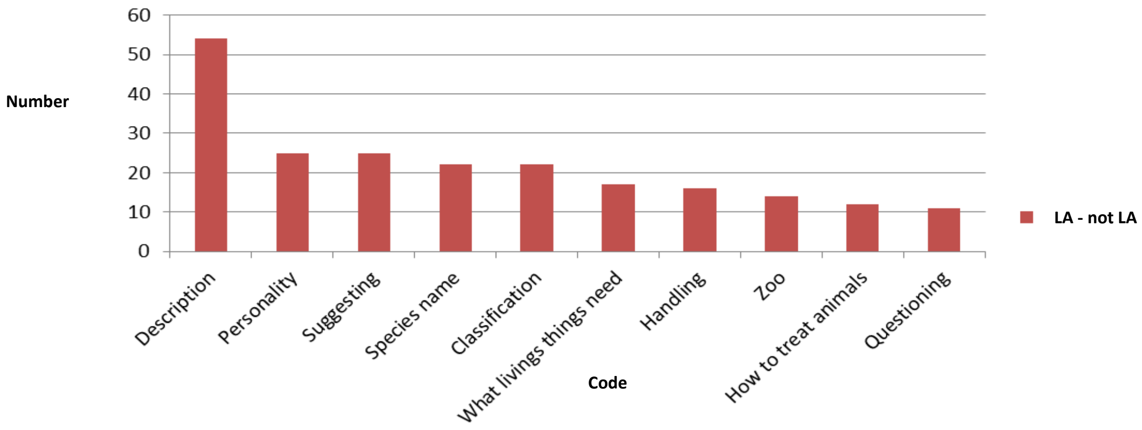


Figure 4.9 Top ten live animal show codes. The y axis represents the difference in the number of responses in each coded category between classes that had taken part in a live animal show and classes that had not. Results are arranged in order of decreasing difference. This includes data from all participants.

4.1.4.3 Natural History Specimen Collection

Figure 4.10 shows that evidence of children learning a species name is most closely associated with a natural history museum visit, followed by information about career choices, followed by observation skills.

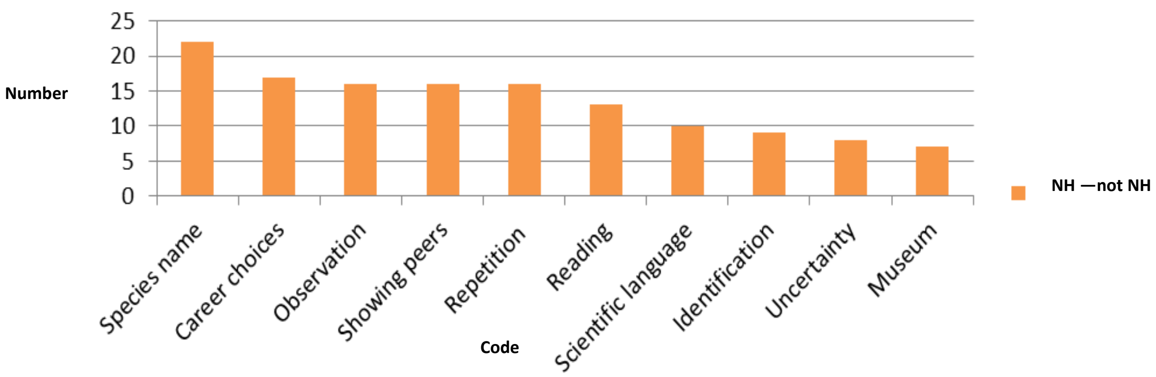


Figure 4.10 Top ten specimen handling codes. The y axis represents the difference in the number of responses in each coded category between classes who had taken part in a natural history session, with classes who had not. Results are arranged in order of decreasing difference. This includes data from all participants.

Figure 4.11 shows a drawing recalling a visit to the Royal Veterinary College Museum. There is a representation of the horse skeleton inside a glass cage, and two boys are beside it. One is saying ‘Look at those hooves!’ and the other exclaims ‘WOW!’, indicating the excitement of the visit. The components of the drawing are in proportion to one other; this drawing is recounting the visit. It could be considered evidence that social learning is important; one child is guided by another, a social signpost pointing out salient objects. Conversation in museums will be discussed further in Section 4.5.

Figure 4.11 A drawing showing recall of a visit to the museum

4.1.5 Complementary learning about biodiversity in a museum, environment centre and at a live animal show

Figure 4.12 shows how the most commonly occurring codes are distributed across domains.

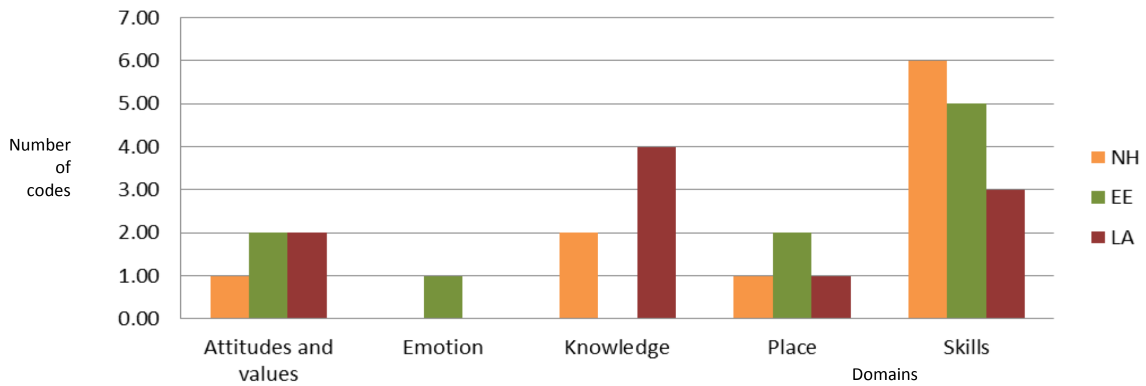


Figure 4.12 Distribution of top twenty most frequently occurring codes per setting, for each domain. The y axis shows the number of codes and the x axis shows the domains. This includes data from all participants.

Figure 4.12 further demonstrates that there are variations in the learning observed in different informal learning settings, despite that fact that all three addressed National Curriculum objectives about habitats and adaptation. Why is there a difference in the domains of learning in different settings? The following Sections will consider observations in detail and relate them to the literature.

4.2 Skills

This Section corresponds to the domain 'Competencies' in the Earth Smarts framework (Nichols and Zeidler, 2012). As a recap of information covered in the methods Section, Nichols and Zeidler's definition of this domain included the ability to learn, community skills, scientific reasoning skills and systems thinking.

Through analysing pre-/post-visit activities, video footage and interviews, I arrived at set of codes shown below in Figure 4.13. This is a close up of the 'tree' diagram shown in Figure 4.1. The codes are arranged in alphabetical order in the Figure, and will be described and related to the literature. Coding was overlapping, in the sense that not all the codes are mutually exclusive, and some utterances provided evidence for more than one code.

Figure 4.13 Codes included in the domain 'Skills'

4.2.1 Skills Codes

Agreement

Agreement refers to a child validating another's point of view. This code arises from the Earth Smarts framework under a sub Section called 'community skills'. Children tended to agree about identification, and about how to treat animals they had found.

Curiosity

Curiosity denotes a natural interest in finding out more information or exploring a physical space. If children asked a question or spontaneously started to explore a space, one tally mark was made for this code. Figure 4.14 shows that imagination, a form of internal curiosity, has been ignited by seeing live animals. The writing is advanced, and this child has recalled a knowledge domain fact: an owl can turn its head fully. The child has thought about the animals in relation to one another, despite the fact that they were not seen at the same time. The child has used imagination to think about what would happen if they were together. Although this drawing is unusual, educators who work with animals would not be surprised to see a child draw a fight between two species, as this is a common question from children (personal experience), e.g. ‘what would happen if a snake and a tarantula had a fight?’. I also think it is unusual that the child has reflected on their own thinking and concluded that it is “strange”. Their use of thought bubbles and speech bubbles shows evidence of awareness of cartoon culture, and personification of animals.

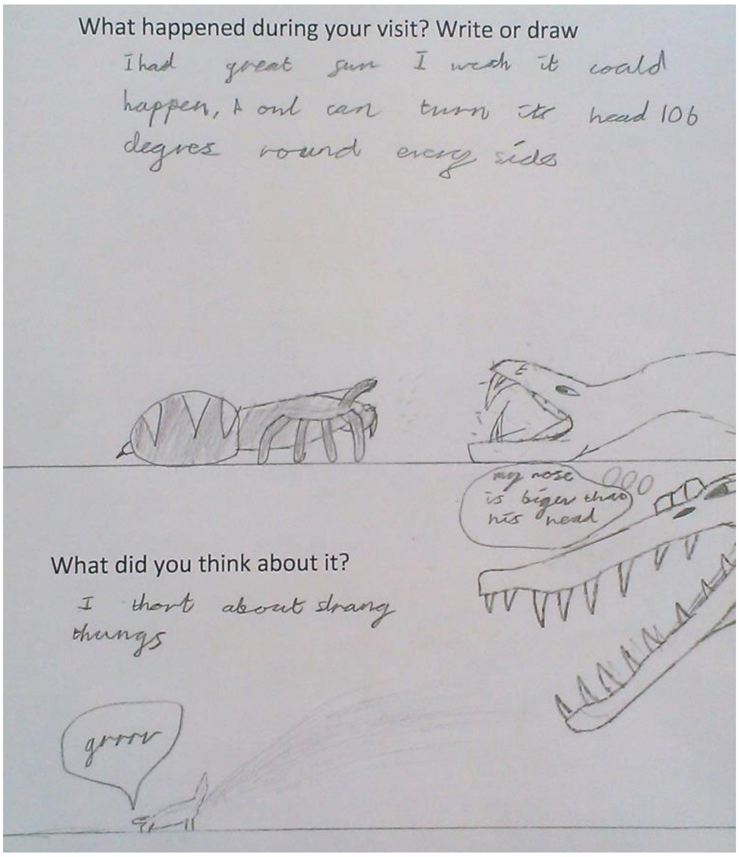


Figure 4.14 Drawing showing curiosity

The images shown in Figures 4.15 and 4.16 are from a post-visit interview video, conducted one week after the school trip took place. This child had brought an invention book, including something inspired by the visit. This is an example of imagination being initiated by aspects of a visit.

Figure 4.15 Post-visit interview showing curiosity

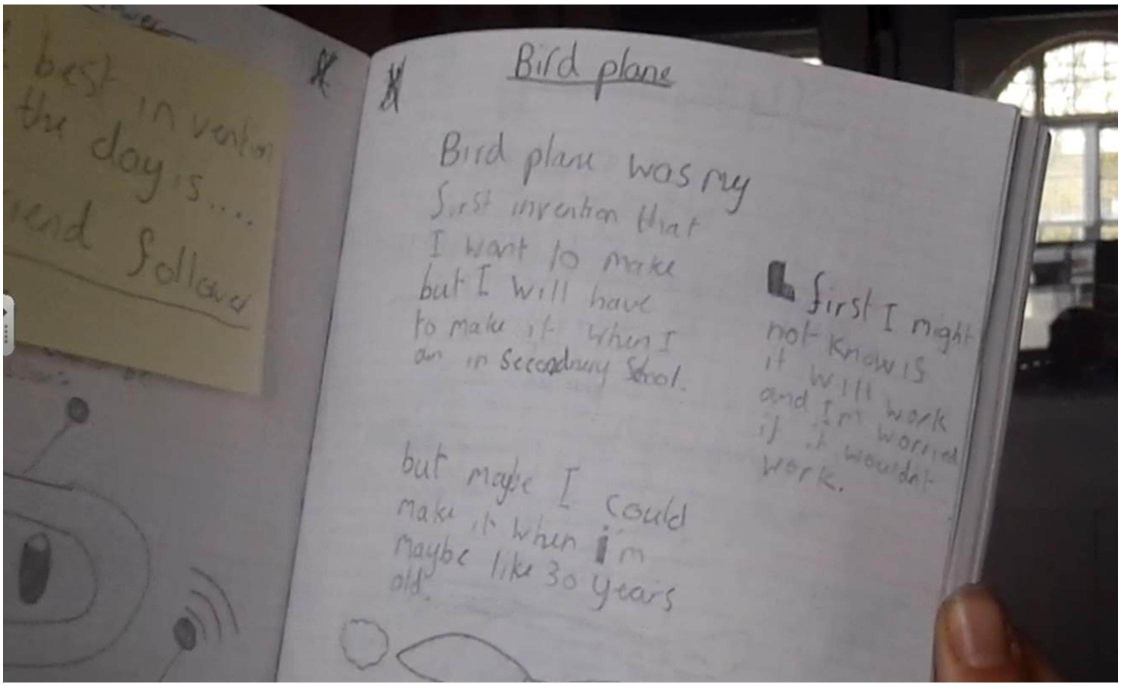


Figure 4.16 Invention book, showing imaginative responses to the EENH visits

Disagreement

I added the code disagreement after observing children having differences of opinion about species identification, how to treat animals, and values. For example, a disagreement about being vegetarian arose after seeing specimens and discussing the taxidermied animals.

The image in Figure 4.17 is from a post-visit interview, where a child who had a high level of pre-visit knowledge about animal species encountered facts during the visit with which he did not agree.

Figure 4.17 Post-visit interview showing disagreement

This boy explains his disagreement. His prior knowledge is from *Deadly 60*, a BBC children's TV programme. The phrase in quotes "How do you know that?" is the interviewer speaking. This is also an example of using evidence.

Evidence

This code refers to children calling on evidence to back up a viewpoint, for example, asking other children to look at features on a real specimen to back up their identification conclusion. This is a key skill in scientific reasoning.

Explaining

Where children used the word 'because' (whether in pre-/post-visit activities or video evidence) this was recorded as evidence of 'explaining'. When children were working together around an activity in the museum there were a number of instances of children explaining vocabulary and justifying their choice of response. Nichols and Zeidler (2012) consider this to be a community skill.

Handling/sensing

I grouped the senses touch, sight, sound and smell to form this code, which includes children using their senses to describe and understand aspects of their environment.

Identifying

Identifying refers to the skill of correctly naming a living thing or specimen. This code was recorded when children used evidence to correctly name a species. It was not recorded if they, for example, repeated the name or showed the living thing or specimen to a peer. In contrast, the code 'species name' would be recorded for those events.

Involving/fairness

Involving or fairness was a code from the Community skills Section of the Earth Smarts framework. It refers to children making sure that people in the group are included. For example, at Camley Street nature park children spontaneously got nets so that their friends could take part in pond dipping (as shown in Figure 4.18).

Figure 4.18 Children pond dipping at Camley Street Natural Park

Judging

When grouping animals into different types of vertebrates using specimen collections, children had to make a choice about whether, for example, teeth were flat or pointed. Making a judgement such as this requires understanding the terms and applying them to a new situation, often by making a comparison with an example that they have been shown by an expert adult or peer. I added this code after observing video data, and it relates to the comments about child development regarding species identification.

Measuring

This is a scientific skill, and having a real purpose and context for measuring is seen to be good practice in classroom science and maths teaching. The scientific skill of measuring was used in the environment centre, when children took part in an activity to measure the effect of hibernation. The investigation demonstrated that insulation reduces temperature loss.

Observing

This code was used when children looked closely. In contrast to 'Searching', 'Observing' may not be a sustained activity. So, for example, they might look through a magnifying glass at fine detail on a minibeast. Evidence was either from videos or via recorded evidence in the form of post-visit drawings. Observation is a key scientific skill (Braund and Reiss, 2004). The museum was where this code was found the most. The children were asked to look at aspects of animal features in order to classify whether the animals were carnivores, herbivores or omnivores, as a starting point for considering their habitat. Children were frequently seen to look at the skull teeth for a sustained period of time, and also to discuss this with their peers.

In Figure 4.19, a child explains his observation of ducks.

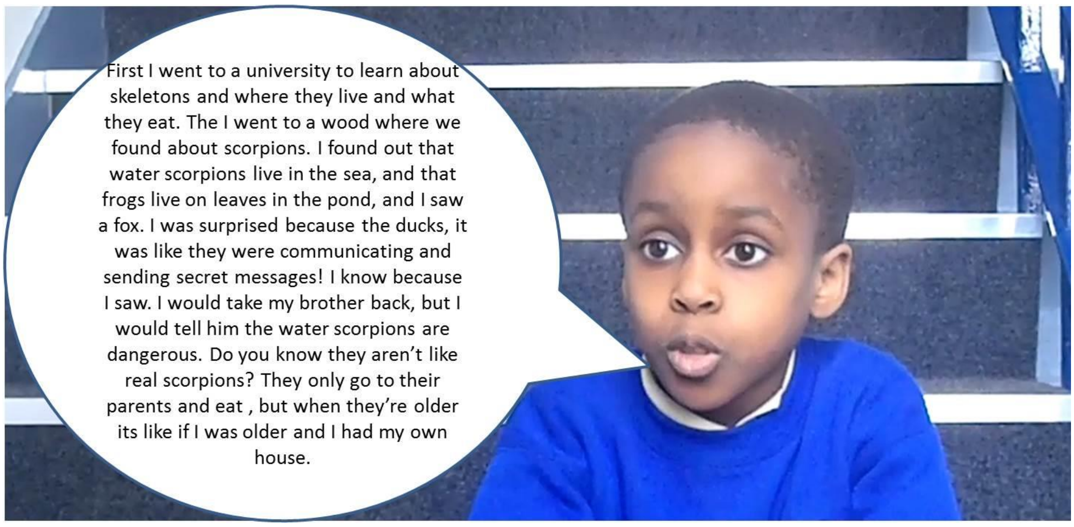


Figure 4.19 Post-visit interview- evidence of observation

Prior experience

When children referred to personal experience in other contexts in conversation, in video evidence, then a tally mark was made for this code.

Reading

I added this code after hearing children reading specimen labels and environmental signage aloud whilst exploring these spaces.

Repeating

It is clear that children repeat others' and teacher's use of new and unfamiliar words in order to cement new learning. This happened spontaneously, and would often take the form of playing with the words, saying them with different intonation or voice, or singing. Through observation, singing was more likely to happen outside. Figure 4.20 shows children singing in the rain at Camley Street Natural Park.

Figure 4.20 Children singing in the rain at Camley Street Natural Park

Some people may consider this to be a communication skill but, as explained earlier, there is a difference between a child repeating a new word, trying it out in different voices and at different paces, for example, and when they are using it for communication, in which case it is often accompanied by an imperative phrase.

Scientific language

This refers to children using scientific vocabulary that had been covered during the session, for example, 'habitat' or 'mammal'.

Searching

Searching refers to a sustained activity of observing, which may result in discovering something. In contrast to curiosity, it is not necessarily spontaneous. The key aspect of this code is persistence, which may or may not result in finding a specimen or living species. I added this skill as I feel it involves a specific set of behaviours (observation, scanning, often moderating noise levels). I would consider this to be part of scientific reasoning.

Showing

Having identified a specimen or species, either independently or with assistance, children sometimes showed it to their peers. This cycling of expertise within groups spread the learning. This is consistent with Doris Ash's (2007) work on thematic continuities. 'Showing' differs from 'explaining' because children are not using the word 'because' or showing higher order reasoning. Instead, showing is indicated by an imperative phrase or beckoning gesture, and often by use of an animal's name. In order for this code to be recorded, the label for the animal they were 'showing' did not have to be correct, whereas for identification it did. Figure 4.21 shows Environmental Educator Helen commenting on her perception of pupils showing others what they have found out.

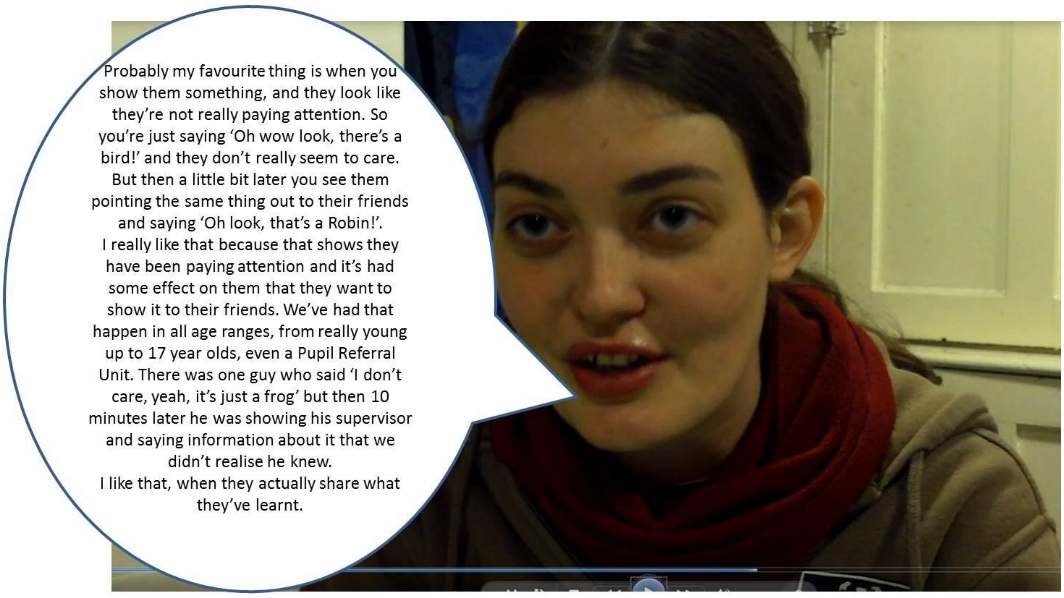


Figure 4.21 Informal Educator post-visit interview: discussing experience of pupils showing one another what they have learnt

Sorting

This referred to grouping living things into types, for example, herbivore, carnivore or omnivore in the museum. In the environment centre, children sorted species into a food chain display as a plenary activity. Sorting is a key scientific skill which is also involved in categorisation.

Suggesting/experimenting

This code refers to children trying out ideas, either verbally or by manipulating resources. I have amalgamated these two terms into a single code as, although one refers to an intangible process, whereas the other has a tangible outcome in terms of moving physical resources, it could be argued that they are essentially part of the same scientific process, which is, generating a range of solutions to a given problem. Experimenting includes the practical aspect of trying out solutions, whereas suggesting is verbal only. These are part of scientific reasoning, and were seen most in live animal shows. Again, the accepted pedagogy of these shows lends itself to children making suggesting in response to questions from the educator.

4.2.2 Recalling Environmental Exploration

Drawings have been used to demonstrate different codes in this Section. Figure 4.22 is useful because it shows a number of salient parts of a visit to Camley Street Natural Park. The writing and drawing show evidence of sequential ordering of ideas: first, then, next … The child has drawn a building block activity where they construct a food pyramid, and written about using a thermometer (although it is clear that the reasoning for the activity was not well understood by the child). He draws himself mixing ingredients, and he has remembered the different food needed well. The labelling shows evidence of awareness of scientific drawing. He has also shown himself using binoculars in a separate drawing, although he does not show what he was looking at. Like many children's drawings of ponds (Reiss et al., 2007), the final representation includes the vegetation around the pond; it is seen as an object which includes its surroundings rather than just as water. This is likely to be evidence of the influence of visual culture; ponds are frequently shown in books as being situated in the landscape and containing water lilies etc. He clearly enjoyed the visit! Again, it is clear that the parts of the trip which involved objects (blocks, thermometer, mixing bowl, binoculars) and skills were most memorable. The bird cake would have involved the sense of smell when mixing the ingredients, and the sense of touch as you can feel the texture of the different foods. This provides evidence for the salience theory of informal learning, discussed in Section 5.7.

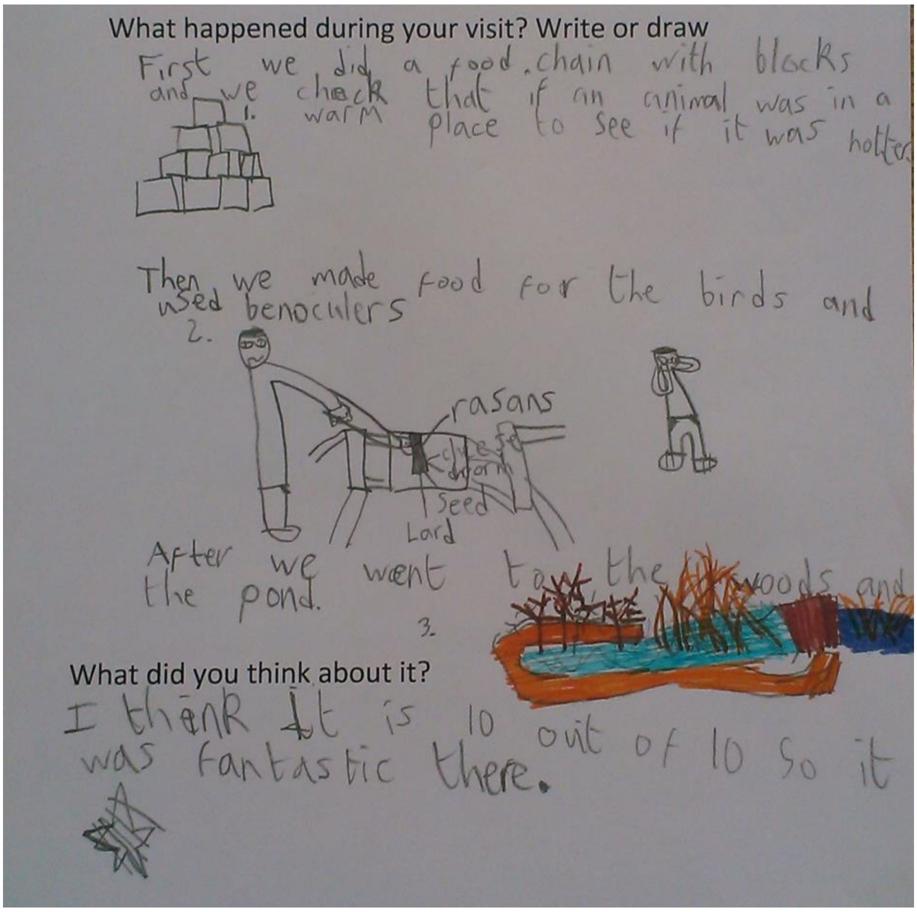


Figure 4.22 A child’s drawing of an environmental exploration. Supplementary evidence included to add richness to quantitative data

This Section has defined skills which pupils showed evidence of having learnt or practised, as a result of informal biodiversity education. The next Section will look at evidence for children’s learning in the domain ‘Place’.

4.3 Place

Figure 4.23 shows the codes in the domain of learning 'Place'.

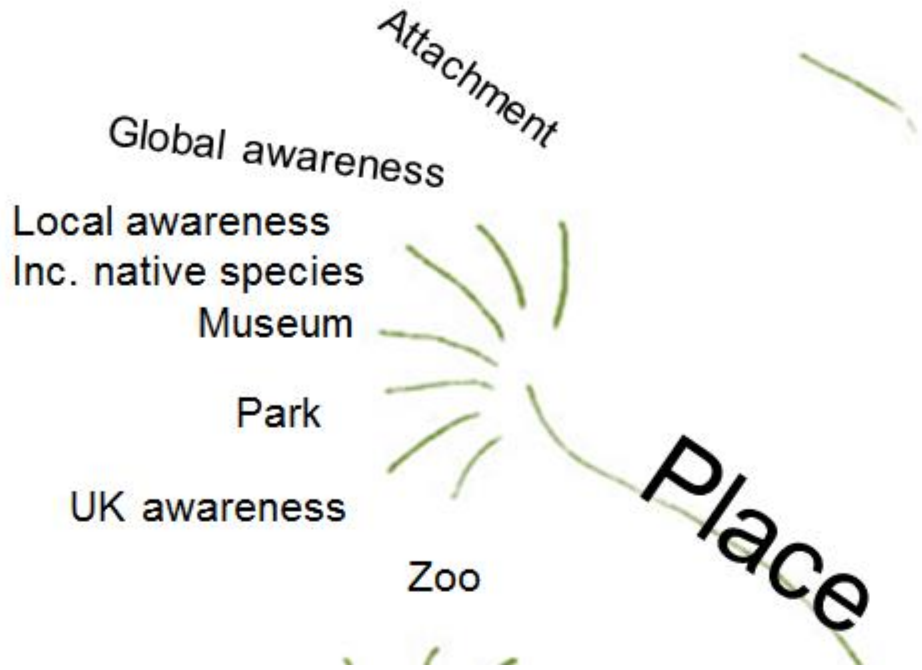


Figure 4.23 Codes within the domain 'Place'

Sense of place is defined by Nichols (2012) as including the following aspects:

- Awareness of local community including issues
- Awareness of global community including issues
- Emotional bond / biophilia / sensitivity
- Self-efficacy.

(www.earthsmarts.info, accessed March 2012)

It might seem that the aspects of emotion discussed in the next Section should fit under this domain; however, I maintain that there is a distinction to be drawn between attachment to a place and general positive emotion. According to Nichols' definition:

> Whatever you call it, an attachment to the land is important – we need to care about our communities and environments, both local and global. This

> connection may be some combination of spiritual, religious and aesthetic factors, and culture obviously plays a huge role. Many modern education systems do not address this well at all, sealing children in "safe", sterile classrooms for their entire development.
>
> (www.earthsmarts.info, accessed March 2012)

This is consistent with ecoliteracy approaches to environmental education (Goleman et al., 2012; Peacock, 2004). The majority of data for 'sense of place' came from pre-/post-visit activities and interviews.

Sense of place is about developing an attachment to a particular area, for example a home area or a place of significance. It is therefore important to understand the sorts of places that pupil participants might be attached to, given that the catchment areas of the schools taking part in the research are diverse.

4.3.1 Languages of the participants

In addition to English, 21 languages were spoken by the participants in the study. In order of decreasing frequency, their languages were: Turkish, Spanish, French, Somalian, Arabic, Bengali, Kurdish, Albanian, Cantonese, Ibo, Yoruban, Portuguese, Tigrinya, Russian, Finnish, Danish (Greenland), Mandarin, Czech, Italian, Punjabi and Ghanaian. This is relevant in understanding the places which pupils may know best.

4.3.2 Place Codes

Attachment

In pre- and post-visit activities, children were asked if there was a natural place they particularly liked. In the pilot study this revealed almost binary responses, with many children instantly being able to identify such a place, for example a park they visited often. However, some children had no such places. This code can be used to show a level of engagement with the natural environment.

Global awareness

This code was used when children referred to species or habitats around the world, either in pre-/post-visit activities or during a trip.

Local awareness

Evidence that children had good local awareness was recorded when they stated the name of a local place in questions about place, or if they showed proficiency in naming specifically local species.

One issue that arose with this question was that children were not clear about the scope of the word 'local'; the definition of 'local' is open to some interpretation. It varies whether it is considered as an alternative to global, in which case local means 'anything which is not from another country', or whether it is in the context of local, regional, national and international, in which case it is a smaller area. Adults find this quite an easy idea to use flexibly, but children find it difficult. For example, many adults would not consider a goldfish which lives in a house to be a good example of a local species, but it can be hard to explain to children why this is the case. There is an assumed meaning of 'local species' in English that excludes domestic animals from the set, even though this is not something that is taught explicitly.

Museum

Following the question about a natural space described above for the 'Attachment' code, children were asked to draw the space they liked. When they drew a museum, this code was recorded.

Park

Following the question about a natural space described above for the 'Attachment' code, children were asked to draw the space they liked. When they drew a park, this code was recorded.

Zoo

Following the question about a natural space described above for the 'Attachment' code, children were asked to draw the space they liked. When they drew a zoo, this code was recorded.

4.3.3 Natural spaces: pre-visit

Question 4 in the pre-visit activity asked children about their connection to place. They were asked to say if there was a natural place or outdoor space that they particularly liked. They were then asked to write or draw about it, explaining why they liked it. 77% children of children answered yes to this question (n=91). In the three classes who took part in a combined day with two sessions, 76% answered yes to this question (n=87). The locations of the places they chose are shown below, at increasing levels of detail in Figures 4.24, 4.25 and 4.26.

Figure 4.24 Connection to place: global level

Figure 4.24 shows that a number of children chose locations which represented their home country (language data was used to ascertain if destinations abroad were holidays or related to their parents' nationalities). These included Jamaica, Somalia, Egypt, Bangladesh, Thailand, Turkey and the Czech Republic. One destination was a holiday: Benidorm in Spain. Pupils often stated a particular habitat, e.g. a beach in Somalia, a garden in Turkey. Red pins represent choices, although they do not show how many children made this selection. A map showing these pins and place marks, together with the percentages of the total sample who selected each choice, can be accessed online by going to http://goo.gl/ywWVQe.

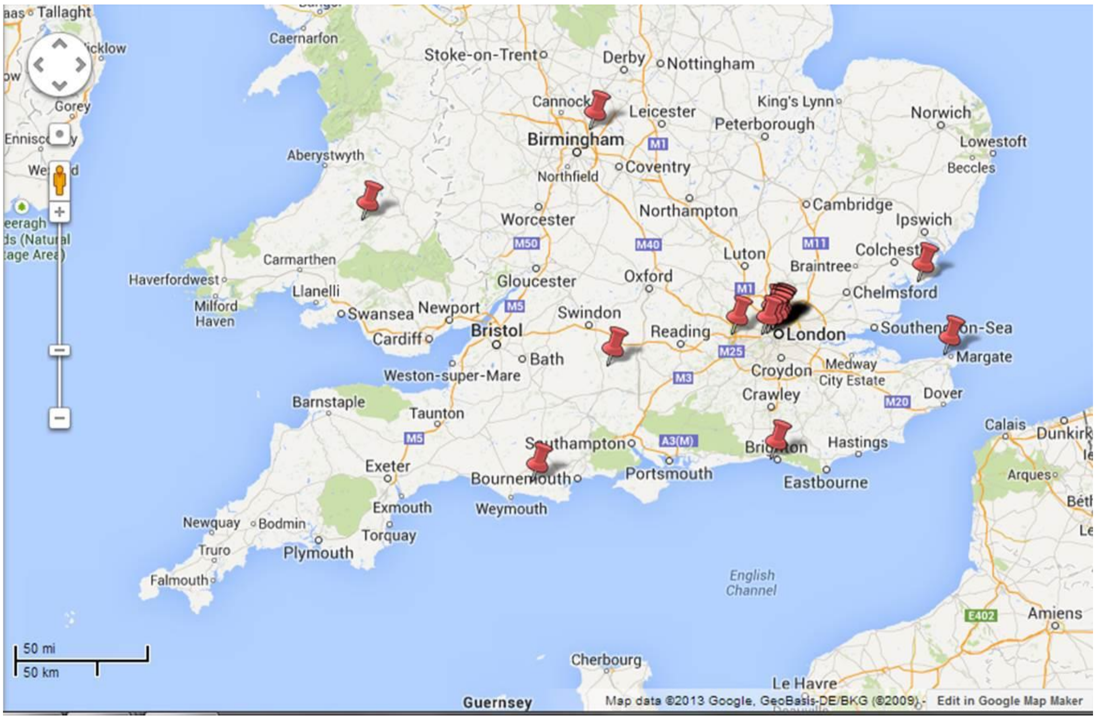


Figure 4.25 Connection to place: regional level

Figure 4.25 shows that a number of children chose holiday destinations as places they were particularly fond of, as well as nature leisure destinations. Examples include Margate, Clacton-on-Sea, Brighton, and Monkey World. Sport played a part in some choices; for example, 'Go Karting in Wales' was one choice.

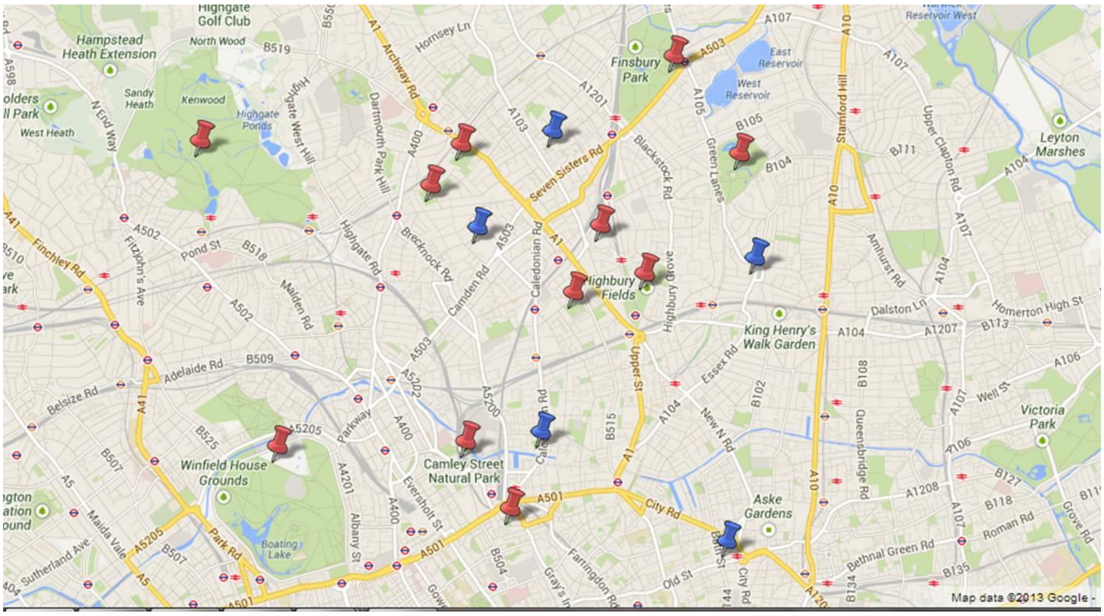


Figure 4.26 Connection to Place: Local level. The red pins show selections and the blue pins show approximate locations of the schools that took part in the research.

Figure 4.26 shows that there are a range of local open spaces selected by children in their response to the question ‘Is there a natural space you particularly like?’, for example, Regent’s Park, Hampstead Heath and Highbury Fields. Again, sport and leisure played a part in their choices. The child who selected Finsbury Park stated ‘the boat ride’ and one child chose Arsenal football stadium as their favourite outdoor place.

In addition, there were a large number of responses ‘park’ or ‘garden’ that did not have a specific location and therefore could not be assigned a grid reference.

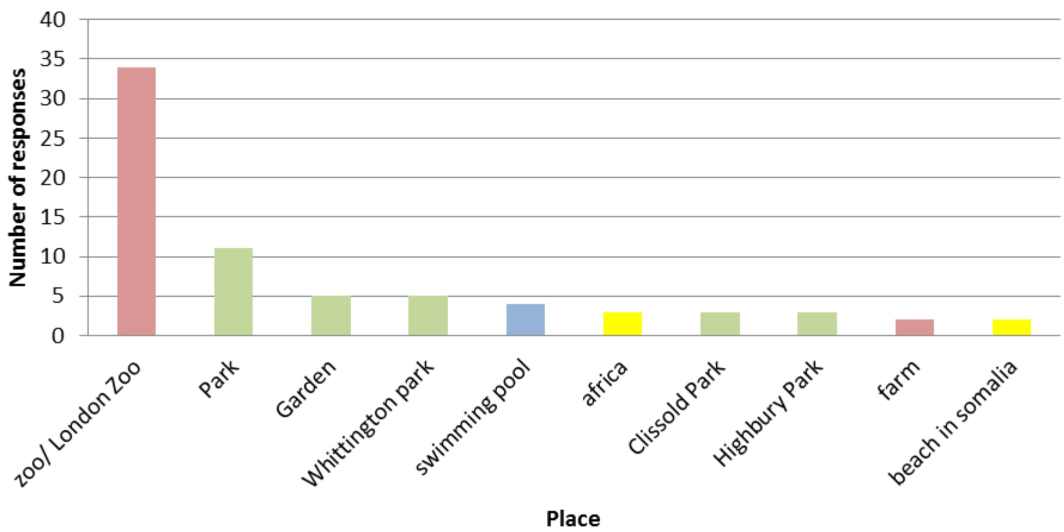


Figure 4.27 Preferred natural spaces, pre-visit. All data. Red represents a place with live animals, green shows a natural space, blue shows a sport facility and yellow shows a holiday/home country. Responses where children wrote the name of a specific location were used to make this graph. Children's use of capitals is repeated in the x axis labels.

Figure 4.27 shows the ten most popular locations chosen by children, in the pre-visit activity, in answer to the question 'is there a natural place or outdoor space that you particularly like?'. It is clear that zoos, and specifically London Zoo, are popular places. Outdoor spaces make up the other top choices, with a few choices representing home countries. A swimming pool is a popular choice; there are a lot of outdoor swimming pools in London which may explain their inclusion in this Section. This question included a large number of responses which only had one answer, reflecting the fact that this question is frequently a very much individual choice.

4.3.4 Natural spaces: post-visit choice

Does visiting a place increase children's likelihood to see it as a place they particularly like or connect with? In Figures 4.28 to 4.33, consistent with the other Figures in this results Section, natural outdoor sites are coloured green, live animal settings are coloured red, and museums or indoor sites are coloured orange.

Holidays are shown in yellow. It is a reasonable to predict that children who had visited Camley Street Natural Park might mention it as an outdoor site they like, and therefore we would expect to see more green in the pie charts shown in Figures 4.28, 4.31 and 4.32 than in 4.29, 4.30 and 4.33. Likewise for live animals, one could predict that there would be a larger number of red segments in the pie charts in Figures 4.29, 4.31 and 4.33 (which show results for children who had encountered live animals) than in the other pie charts. For specimens I would predict that more orange segments may be seen in Figures 4.30, 4.32 and 4.33 than in the other pie chart results.

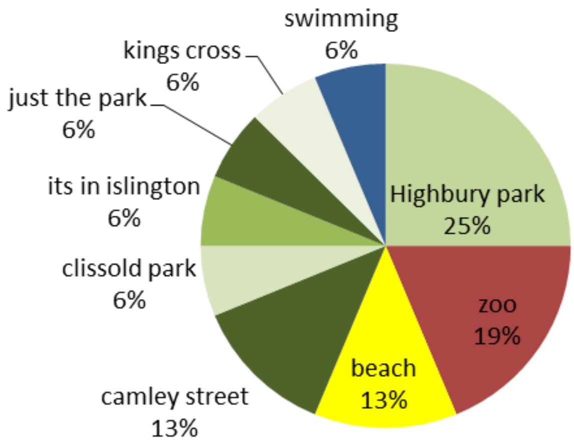


Figure 4.28 Connection to place post-visit: environment exploration only. Spelling and punctuation are as used by pupils in responses. Only pupils who had visited the environment centre are represented here.

Figure 4.28 shows that 69% of children suggested an outdoor site after visiting Camley Street Natural Park, including two children who named Camley Street Natural Park directly. This is greater than the pre-visit average of 36%.

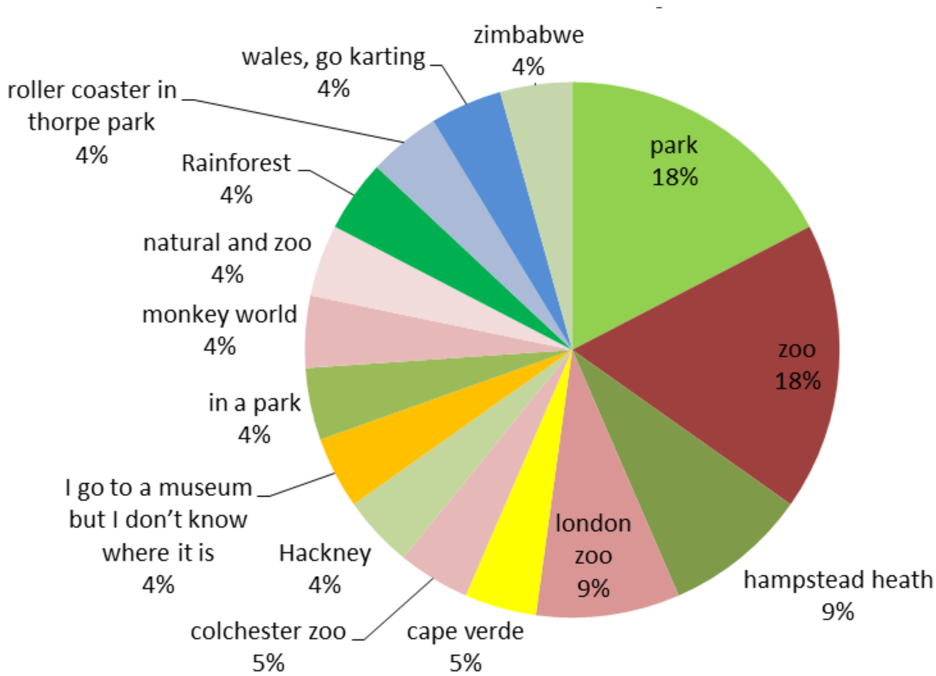


Figure 4.29 Connection to place post-visit: children who visited the live animal show, whether as a standalone activity or with another activity, are represented here

Figure 4.29 shows that 40% of children named a zoo or live animal site after seeing a live animal show. This is only slightly greater than the pre-visit average of 34%.

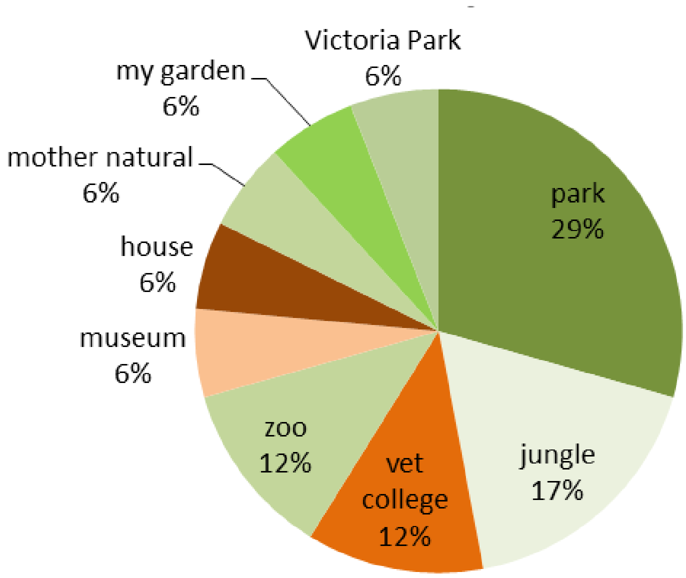


Figure 4.30 Connection to place post-visit: only children who visited the museum, whether as a standalone activity or with another activity, are represented here

Figure 4.30 shows that 26% of children mentioned a museum or indoor space, or the Royal Veterinary College, after a visit to the Royal Veterinary College. This compares with a pre-visit Figure of only 2%.

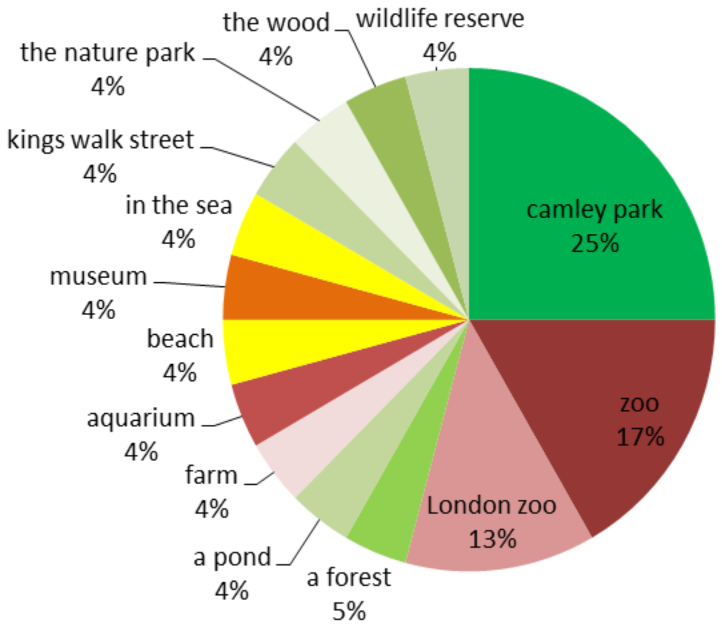


Figure 4.31: Connection to place post-visit: children who visited both the environment exploration and the live animal show, are represented here

Figure 4.31 shows that 52% of children selected a park or natural park habitat after both visiting Camley Street Natural Park and seeing a live animal show. The pre-visit Figure was 36%. 38% of children selected a live animal site, just 4% more than the pre-visit Figure.

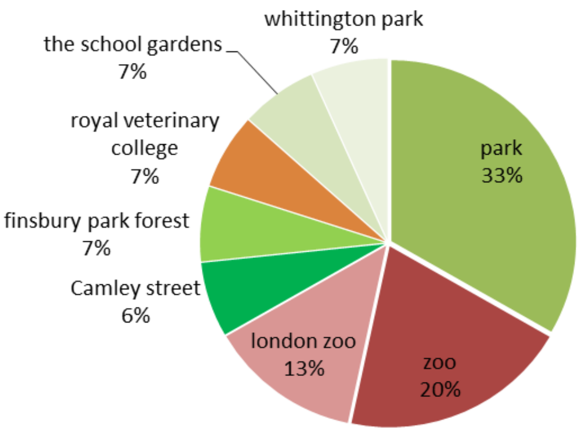


Figure 4.32: Connection to place post-visit: children who visited the museum and environment exploration, are represented here

Figure 4.32 shows that after visiting Camley Street Natural Park and seeing specimens at the Royal Veterinary College, 60% of the children selected a park or natural space as a place they particularly liked. This is greater than the pre-visit average of 36%. 7% selected the Royal Veterinary College, compared to the pre-visit average of 2%. The percentage selecting live animal sites is no different post-visit, with 33% as opposed to 34% pre-visit.

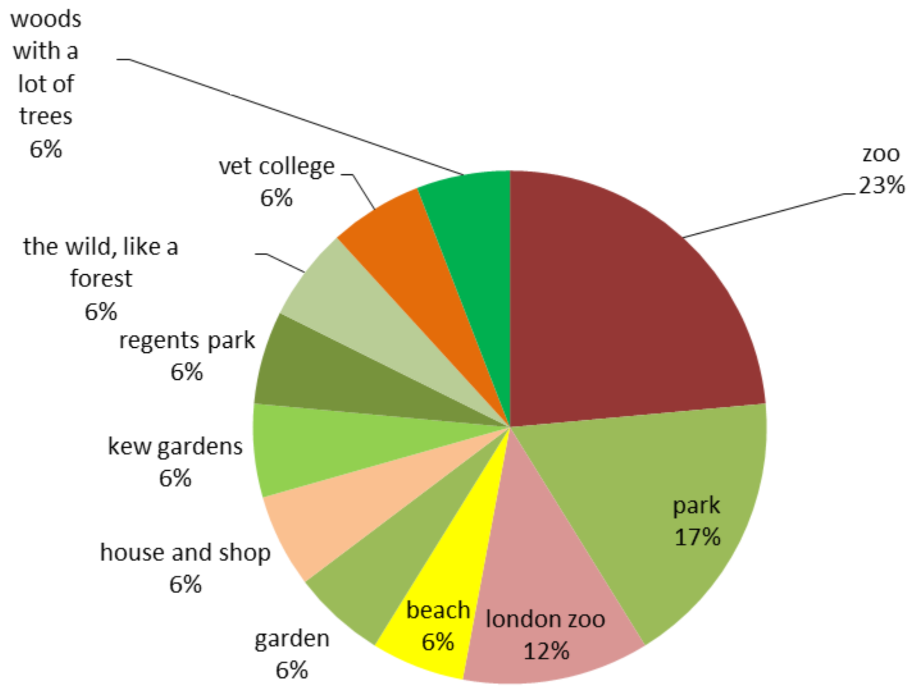


Figure 4.33 Connection to place post-visit: children who visited the live animal show and museum are represented here

Figure 4.33 shows that 35% of children selected a live animal site after seeing live animals and specimens. 6% selected the Royal Veterinary College.

4.3.5 Developing concepts of natural spaces

There were fewer selections of holidays, countries or sporting locations post-visit; therefore, there is some evidence that visits can influence children's attachment to places and understanding of the concept of a natural space. There is some evidence that visiting a place can cue recall of another similar place, which will be discussed further in the next Section.

This Section has presented evidence that children develop attachments to a place as a result of visiting an environment centre, live animal show or museum. The next Section will look at emotional learning.

4.4 Emotion

Whilst the Earth Smarts (Nichols and Zeidler, 2012) framework includes values and attitudes, these are for moral development, justice and respect for others (diversity), rather than developing positive attitudes towards nature in general. The domain 'Sense of place' includes the aspect 'Biophilia', but in Nichols and Zeidler's definition this is specifically about developing an affective connection with place and the environment, rather than expressing a range of emotions.

Therefore, it is important to understand that the results presented in this Section are here because they were observed directly, rather than is the case for the other domains, where the observation framework was designed specifically to gather evidence under coded headings. Evidence is largely in the form of qualitative responses seen in video or interview data, or from the extension activity (what happened today? What did you think of it?) described in Section 4.1.

The Earth Smarts framework is more suitable than the Generic Learning Outcomes (used in the pilot study) for planning and understanding learning about nature; however, I think that the domain of emotional learning should also be involved. By emotional learning, what is meant is having an experience whereby a particular emotion becomes associated with a particular stimulus. The evidence that a child expresses fear does not necessarily mean that they have become fearful through, for example, seeing a snake. If they express fear, and subsequently have a positive experience encountering the animal, then their fear may well be reduced.

Developing the fine-grained detail of emotions in this domain could be a topic for future research. Since it was a subsequent addition to the analysis framework it has few sub-domains compared to the other domains.

4.4.1 Emotion Codes

Motivation

Many responses were recorded for the code motivation, with evidence largely from video data. Positive exclamations were taken as motivation, based on work by Barriault and Pearson (2010). Figure 4.34 shows evidence of motivation through excitement when encountering a live millipede!

Figure 4.34 Excitement and motivation at a live animal show. One girl, indicated by the yellow ring, seems particularly excited!

The greatest evidence of motivation was seen at the environmental education centre, where children responded with delight on discovering an unexpected species, in a real scenario. Frequently, the living thing that prompted a great deal of emotional response was not something that would be considered by adults to be particularly unusual or significant, for example a slug or snail. However, what seemed to motivate the children was the fact that it was surprising for them to find something. Children have very few opportunities to explore a new space, particularly urban children who live near King's Cross. In addition, children are frequently taught using demonstrations, rather than participating in genuinely unprepared situations, and being in a natural space allows the unexpected to happen; it provides an authentic situation that even adults are not 100% in control of. This is something which really seems to fire up children's imagination. In support of this, Birney (1988) found that children who visit zoos generate far more affective responses than children who see preserved specimens in museums.

Disgust

Many children expressed disgust at dirt or mud when outdoors. The other main examples were when children observed dead specimens in jars, while the fetuses in the veterinary college were often a source of disgust, though sometimes fascination. A painting of a monkey fetus from the RVC is shown in Figure 4.35.

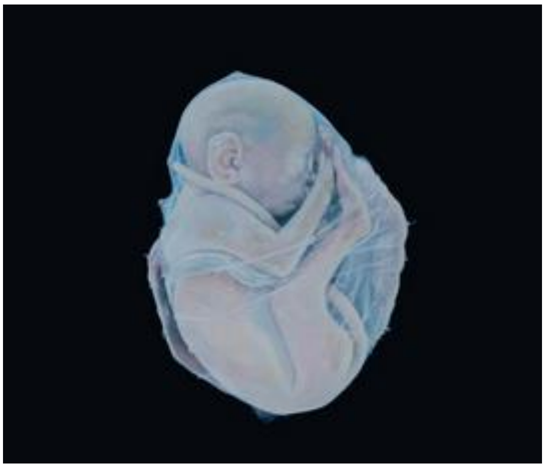


Figure 4.35 RVC artist in residence's painting depicting a fetus, which attracted much attention from children. Permission from Geoffrey Harrison, Artist.

Fear

The code ‘fear’ was recorded when children expressed fright about live animals or exploring unknown spaces. Figure 5.36 is from a post-visit interview; handling the hedgehog reduced the interviewee’s fear.

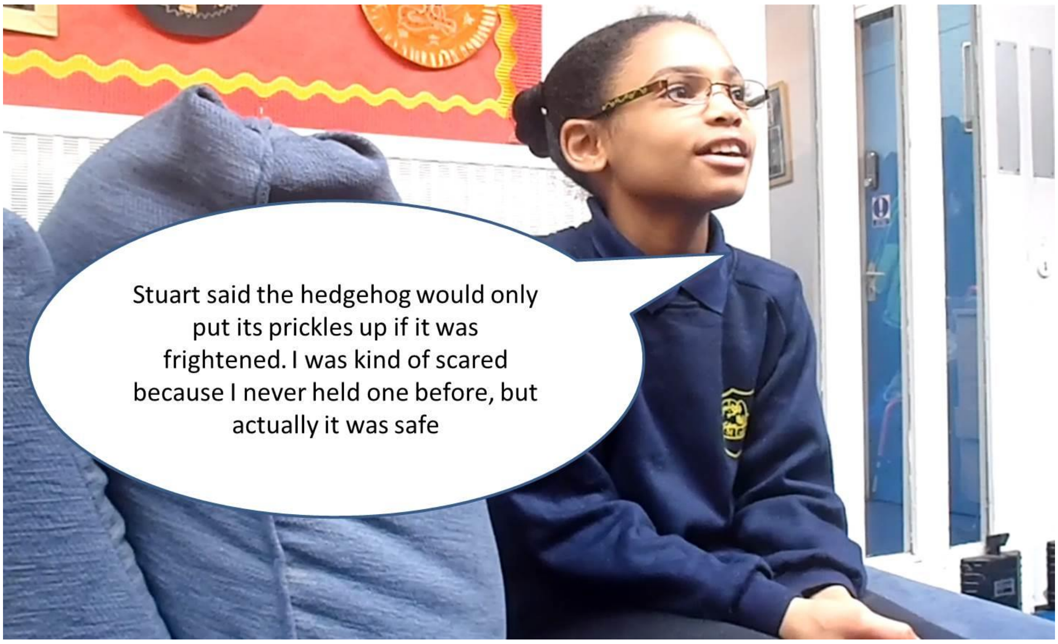


Figure 4.36 Post-visit interview: meeting a live animal can reduce fear

Figure 4.37 shows recall after a live animal show. This child has recalled the owl, the snake, the millipede and the skunk. The writing shows that she enjoyed the humour of the experience, and that the visit did not make her frightened, as she had expected. Having formed an expectation of what would happen, she was surprised by the reality. This is an example of cognitive dissonance, and will be discussed further as part of a Salience Theory of Informal Learning in Section 5.7. In contrast to previous drawings, this one shows evidence of awareness of some of the conventions of scientific illustration; the animals are labelled. However, there are no natural interconnections between the objects and there is no attempt at a consistent scale for the representation of size. This atomistic representation may be related to the sequential presentation of the animals in a live animal show; they are not brought out together because a) they might be prey and predator b) there is often only one person running the show. It would be interesting to compare drawings of animal shows where only one animal is presented at a time, with drawings at safari parks where different species co-exist, as far as predator-prey relationships allow within a leisure setting.

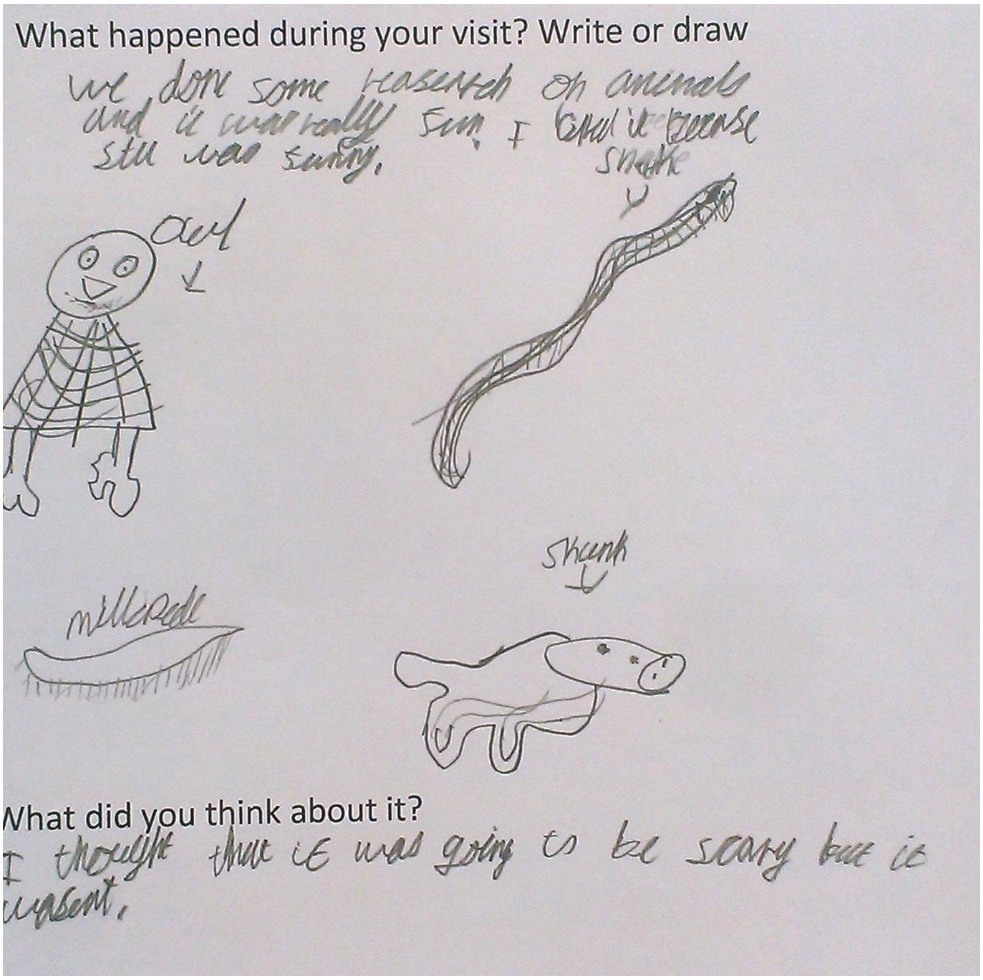


Figure 4.37 Drawing after a live animal show illustrating reduced fear.

The importance of these emotions for memory will be addressed further in Section 5.7, using evidence to suggest a salience theory for informal education.

4.5 Attitudes

The domain 'Attitudes' in the SPEAK framework corresponds to the domain 'Values' in Nichols and Zeidler's (2012) Earth Smarts' framework. As explained in the methods Section, Nichols and Zeidler see the domain as including moral development, justice and respect for others.

Evidence in this Section comes from pre-/post-visit activities, video evidence and interview data. Codes will be described, before looking in more detail at the findings. Figure 5.38 shows the codes in the domain 'Attitudes'.

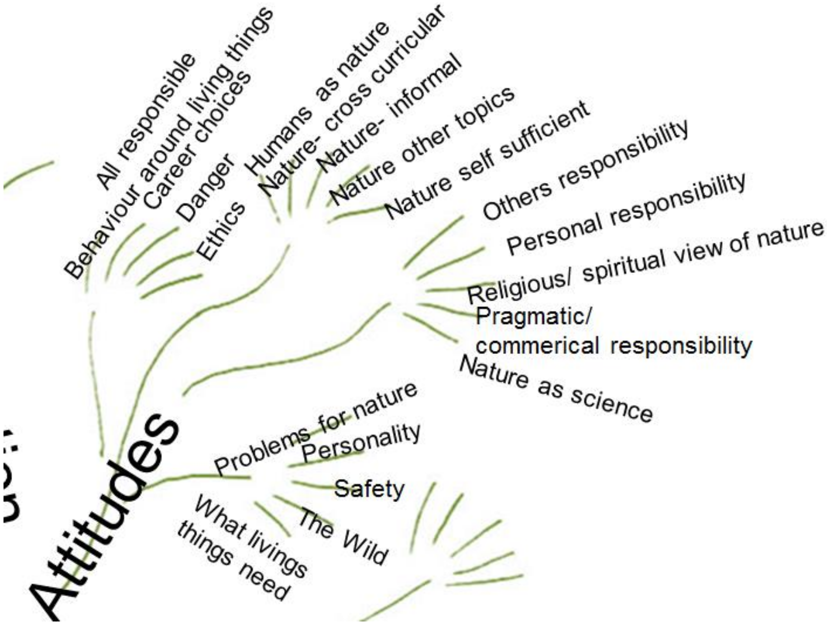


Figure 4.38 Codes for the domain 'Attitudes'

4.5.2 Attitude Codes

Be kind to animals

Themes of caring for animals were clear, particularly in live animal shows. This code was recorded when children expressed views such as 'be quiet, don't frighten them, or be gentle'.

Career choices

In the museum, children expressed views about the sort of jobs that might use a museum collection, and the conversation was opened up to include the sort of careers that needed university qualifications. One boy linked the visit to knowing that his aunty went to university, as shown in Figure 4.39.

Figure 4.39 Post-visit interview relating to career choices

Dangerous/venomous

During live animal shows children frequently had opinions about how deadly a species was. Some people consider that "The fear of certain animals is 'innate'' (Bennett-Levy and Marteau, 1984:17), but others see a range of reasons for negativistic attitudes – active avoidance due to fear, dislike, indifference (Kellert and Berry, 1980). Alternatively, dislike is contrasted with a doministic attitude – mastery and control of the animals, such as hunting and certain sporting situations. An opposing view is known as naturalistic, i.e. nurturing. Studying 10-11 year olds in the US, Brink (1984) found that pet owners or those with class pets had more positive attitudes towards animals.

Ethical questions

This code links to 'curiosity', considered in this thesis as a skill. Asking questions, for example, about where animals came from, and why they were there, revealed children raising ethical issues, or making assumptions. Figure 4.40 shows a post-visit interview with a girl who thought that hunters had killed the animals she saw as skeletons in the Royal Veterinary College.

Figure 4.40 Post-visit interview showing an ethical question. The question in speech marks is the author’s voice.

Humans as nature

This code was recorded when children commented on humans being included in the concept of living species, for example, a human skull shown as a comparison in the museum collection, or an image of a human alongside images of living things that might be seen in outdoor spaces.

Personality

This code was recorded when children referred to the names of animals, or anthropomorphised specimens and suggested they had characters, such as referring to the Chinchilla as “cute”. Patrick and Tunnicliffe (2013:64) found that “Children’s comments are largely anthropomorphic in nature”, e.g. a child commenting that a toucan was sad because it had no friends.

Problems for nature

Figure 4.41 illustrates the answers to an open-ended question: “Do you know of any problems for plants and animals”. Responses showed a range of worldviews from specific and personal, “people pick flowers”, to statements with greater generalisation “their homes are destroyed”. I classified the open-ended responses into discrete catergories for communication purposes.

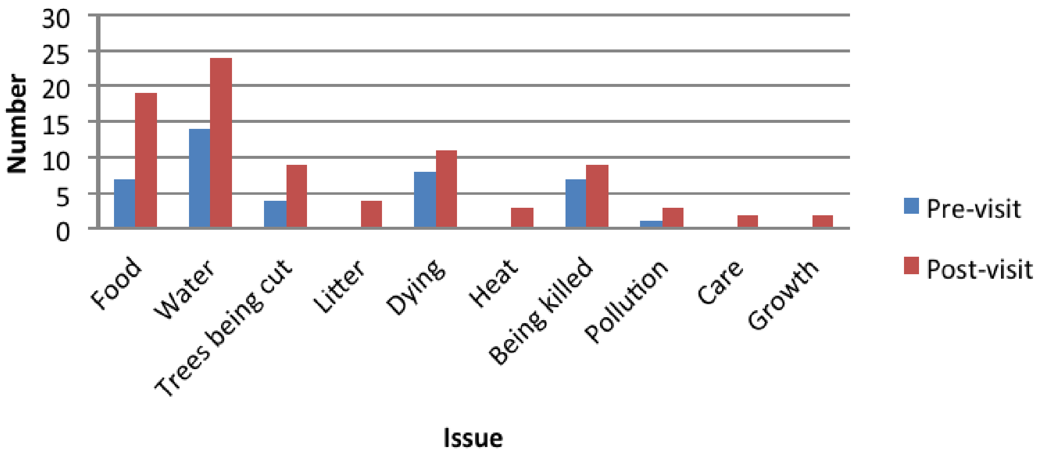


Figure 4.41 Children’s ten most commonly expressed views about problems for plants and animals, with the number of responses pre- and post-visit arranged so that those with the greatest difference between pre- and post-visit are shown on the left hand side. Data obtained from all participants; Question 6 of the pre-/post-visit activity.

Following the visits, children were more likely to identify sources of food and water as problems for animals and plants. Trees being cut down, too much rubbish and not having enough care were also more likely to be responses following visits.

It is a matter of debate whether this information should be included in this Section, or in the one about knowledge. However, I feel that the range of responses reveals attitudes about nature which range from a domestic view of animals to a holistic view of nature. Therefore, I feel it belongs in this Section.

Safety

This code was recorded when rules to preserve health were mentioned by children.

Views of nature

Children were asked in pre- and post-visit activities which lessons or activities would help them learn about nature, the results of which are shown in Figure 4.42.

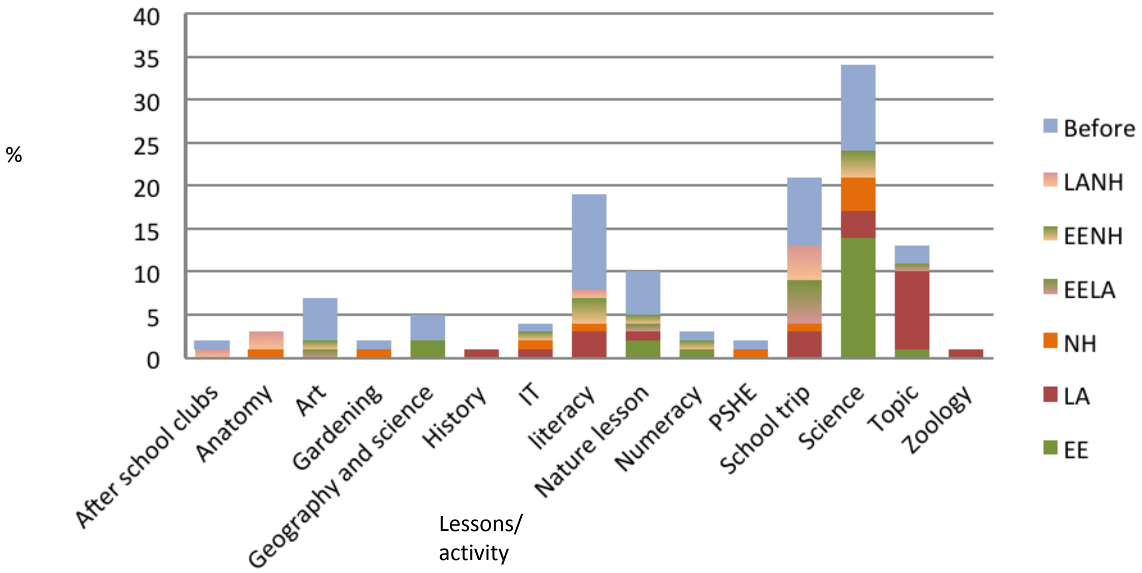


Figure 4.42 Views of nature. Children were asked which lessons/activities would help people learn more about nature. The y axis represents the % of total responses (some children stated more than one choice). All participants are represented.

Figures 4.42 shows that before their visit children were most likely to identify formal lessons, such as literacy and science, and school trips as helping people learn about nature. After their visit, children who had attended Camley Street Natural Park only were most likely to suggest science as the lesson that would help people learn about nature. Children who had seen live animal shows were most likely to identify the cross-curricular lesson ‘topic’. Science was chosen most frequently by children who had seen specimens only. Children who had visited both Camley Street and a live animal show, specimens plus live animals, were most likely to identify school trips as ways to learn about nature. Children who had seen Camley Street and specimens were equally likely to select topic and science.

Figure 4.43 and 4.44 show interviews with twins. Whilst one of the twins understood her visit to Camley Street to be about nature, the other focussed on just insects. How children develop concepts of nature is the subject of research, for example Klaar et al. (2014). This will be further discussed in Chapter 6.

Figures 4.43 and 4.44 Twins recalling their visit in answer to the question 'Tell me what happened on your school trip last week'

What livings things need

Children were asked what living things need as a pre-/post-visit activity. Question 5 asked children to write down what living things need. Their responses are shown in Figure 4.45 using a Wordle to indicate the relative frequencies of the words they used in their responses.

Figure 4.45 Pre-visit responses: what animals and plants need. Words are shown proportional to the frequency with which they occur as responses

Figure 4.45 shows that children selected water, food and sun as aspects that living things, either animals or plants need to stay alive. Figure 5.46 shows the results of the post-visit responses to the question 'What do living things need?' per group. The presentation of the table means that some groups are included more than once, as the order in which sessions were presented was not investigated as part of this research.

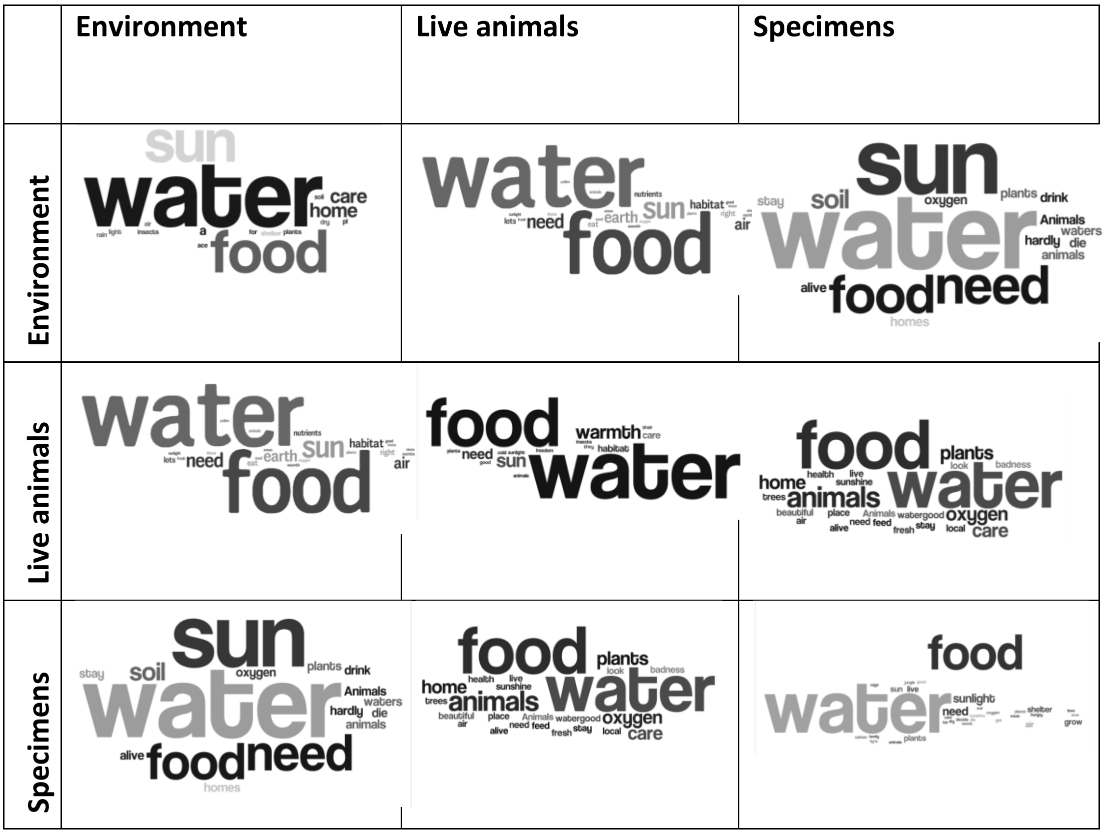


Figure 4.46 Post-visit responses: what animals and plants need. Words are shown proportional to the frequency with which they occur as responses. All classes are represented

There are few meaningful differences between the groups, with the only clear-cut one being that the importance of the sun for plants was stated more often by children who had attended the environment exploration.

Wild vs captivity

This code was added, as it became clear that the concept of ‘The wild’ as opposed to captivity, was new for children and they commented on it. Figure 4.47 shows that children were more likely to state that everybody should look after nature after their visits.

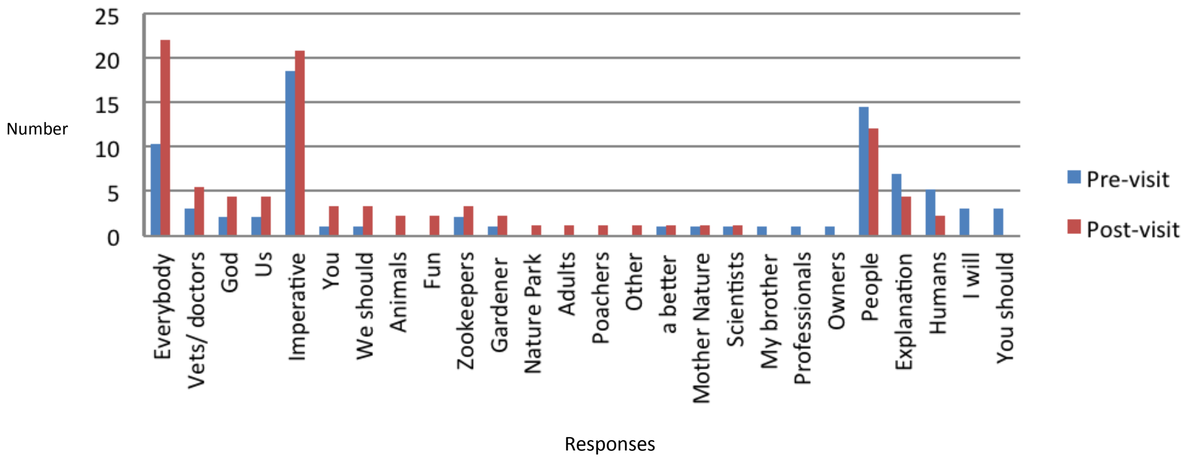


Figure 4.47 Responses to the question: 'who should look after nature?', arranged in order of decreasing difference between pre-and post-visit responses. The y axis shows the number of responses. N.B. Not all children answered this question, although all who answered it are included in the graph

In addition, the perception that vets or doctors should look after nature increased slightly. The discussion, Chapter 5, will consider the choices children made in response to this open-ended question.

Responsibility towards living things

A pre- and post-visit question asked 'who should look after nature?'. The question was open-ended. This code was recorded where children stated 'we should', or 'everyone should'.

Pragmatic/commercial responsibility

A pre- and post-visit question asked 'who should look after nature?'. This code was recorded in response to children saying that gardeners or vets should look after nature.

Religious/spiritual view of nature

A pre- and post-visit question asked 'who should look after nature?'. This code was recorded in response to children saying that God, Mother Earth or Mother Nature should look after nature. I consider references to 'Mother Earth/Nature' to be spiritual, in contrast to specifying 'Nature' as in the code below.

Nature self-sufficient

A pre- and post-visit question asked 'who should look after nature?'. This code was recorded in response to children saying "nature should look after itself" or equivalent.

Others responsible for living things

A pre- and post-visit question asked 'who should look after nature?'. This code was recorded in response to children saying someone else should. Examples included "people who care about nature", "scientists", and "a better government".

Personal responsibility

A pre- and post-visit question asked 'who should look after nature?'. This code was recorded in response to children saying that they themselves should look after nature.

This Section has considered evidence for children learning attitudes about biodiversity. The next Section will look at evidence for children learning knowledge about biodiversity.

4.6 Knowledge

The domain of 'Knowledge' corresponds to Nichols and Zeidler's domain of 'Concepts'. As explained in Chapter 3 it includes Ecological principles, Historical ecology, Essential biology and Earth systems.

4.6.1 National Curriculum in England

In the National Curriculum in England, knowledge and skills are the key areas in the statutory programmes of study. However, it is important to note that Science is not tested though a national regime in English primary schools at the present time (Summer 2014), although it was when this thesis was started, in October 2010. The impact of this change has been an even greater focus on literacy and numeracy skills and knowledge, and these are prioritised over science knowledge in class teaching time (Wynne Harlen, communication at Association for Science Education conference, January 2011).

The codes which I found through gathering evidence for development in learning knowledge are shown in Figure 4.48 and described subsequently.

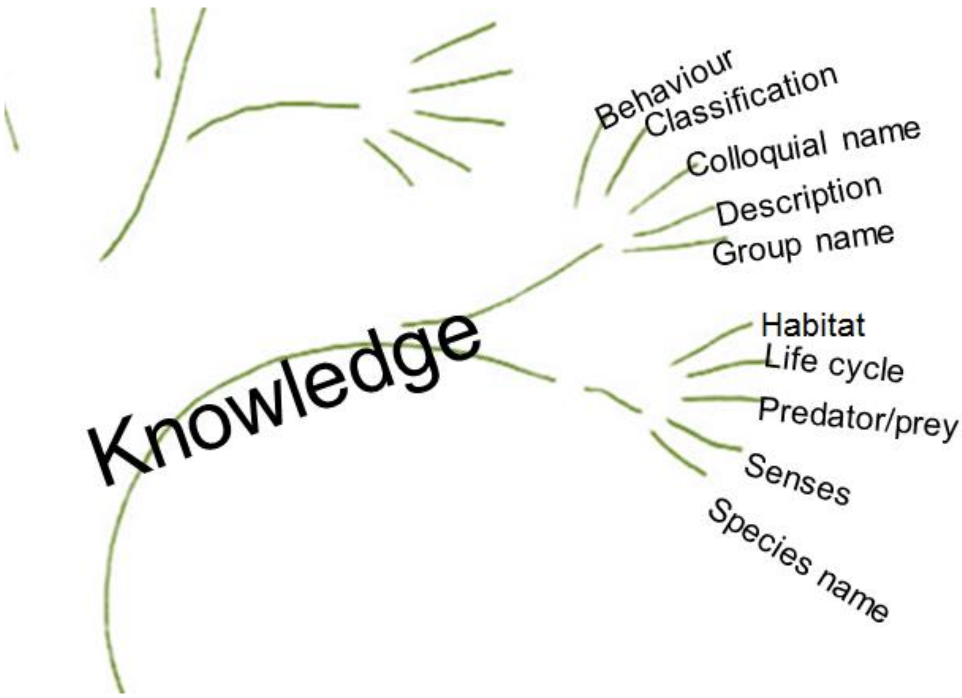


Figure 4.48 ‘Knowledge’ domain codes

4.6.2 Knowledge Codes

Behaviour

This code was recorded when children referred to how animals move or a typical behaviour. These data came from interpreting the pre-/post-visit activity, video and interview evidence.

Classification

This code was recorded when children correctly identified a species as being a type of bird, fish, mammal, reptile, amphibian or invertebrate.

Description

When children described how animals look, their colour, size or shape, this code was used. Description aids categorisation.

Senses

This was recorded if children commented on how animals detect features of the environment.

Habitat

If children named habitats that animals live in, such as woodland or meadow, then this code was recorded.

Life cycle

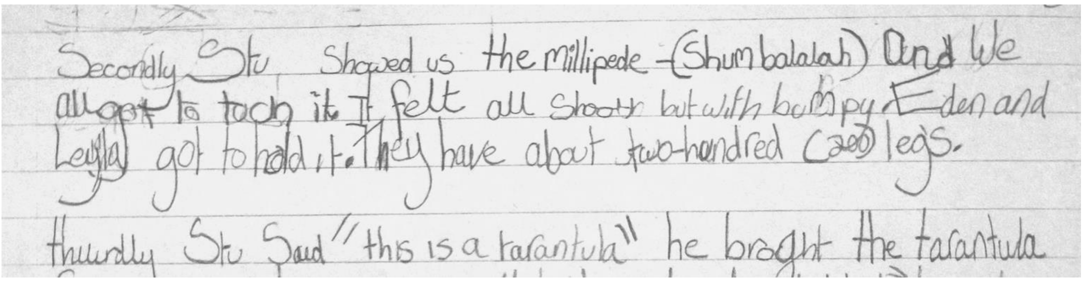
This code was used when children referred to how long an animal lives, or to its young.

Naming

This code links to the skill of identification. However, this code was used when children repeated a name told to them by another, or when they correctly wrote a name in the pre-/post-visit activity. Therefore, this code was recorded when there was no evidence of the process of identification having occurred.

Colloquial name

This was recorded when alternative names were used, such as 'Shambala' for a millipede, as shown in Figure 4.49.


Secondly Stu Showed us the millipede (Shumbalalah) And We all got to tuch it. It felt all Smooth but with bumpy. Eden and Leyla got to hold it. They have about two-hundred (200) legs.

thurdly Stu Said "this is a tarantula" he broght the tarantula

Figure 4.49 Child's writing describing the millipede as a 'Shumbalah'

Group name

This code was used when children stated a group name, such as 'birds'.

Species name

This was recorded if children correctly used a species name. The pre- and post-visit activity questioned children's knowledge of species names.

Predator/prey

When children commented on what animals eat, or what eats them, then this code was used.

4.6.3 Breadth of knowledge about animal and plant species

4.6.3.1 Local

The average number of species that children listed before visiting informal biodiversity experiences was 6.4. This includes species which were incorrectly identified as local. Figure 4.50 shows the range of local species which children knew in the pre-visit activity.

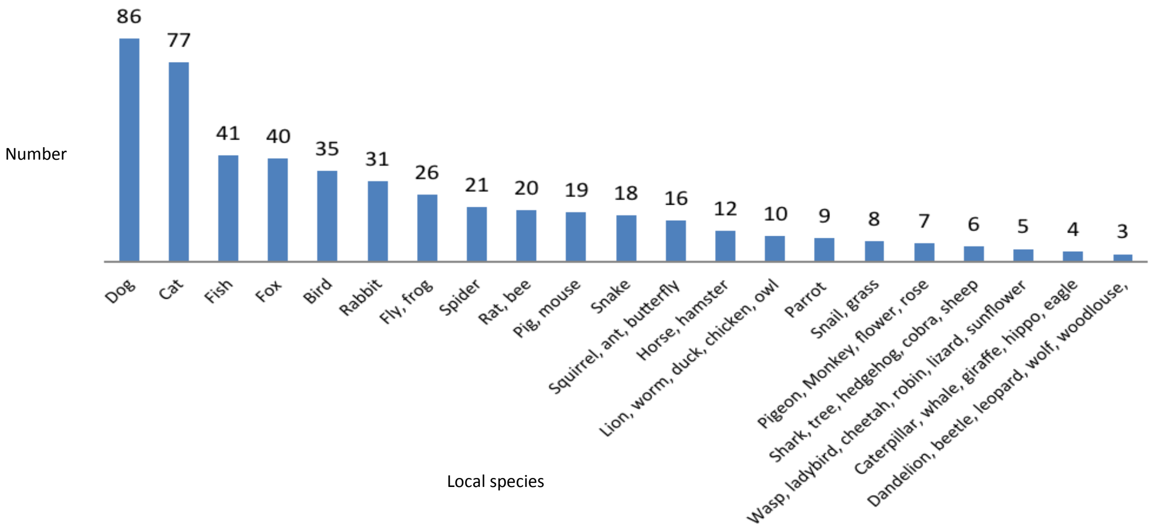


Figure 4.50 Range of local species given in response to the pre-visit question 'Which local animals or plants do you know about? Write or draw'. The numbers show the actual number of responses; data from all pupils.

In addition to the data shown in Figure 4.50, the following species had two responses: Daisy, Toad, Zebra, Slug, Turtle, Lily, Orchid, Guinea Pig, Dinosaur, Bat, Lice, Crocodile, Elephant, Beaver. The following had one response: Adder, Blackbird, Bush, Chameleon, Chimpanzee, Crab, Falcon, Flamingo, Gecko, Gerbil, Goat, Gorilla, Grasshopper, Hawk, Heron, Holly, Hyena, Ivy, Lavender, Millipede, Mole, Nettle, Newt, Pansy, Pheasant, Pike, Poppy, Porcupine fish, Praying mantis, Reptile, Sea horse, Seagull, Serval, Skunk, Tarantula, Venus fly trap, Violet, Vulture and Weeds.
Figure 4.51 shows the top five animals that children named in response to the question 'which animals and plants do you know about?', both before an informal biodiversity visit, and after.

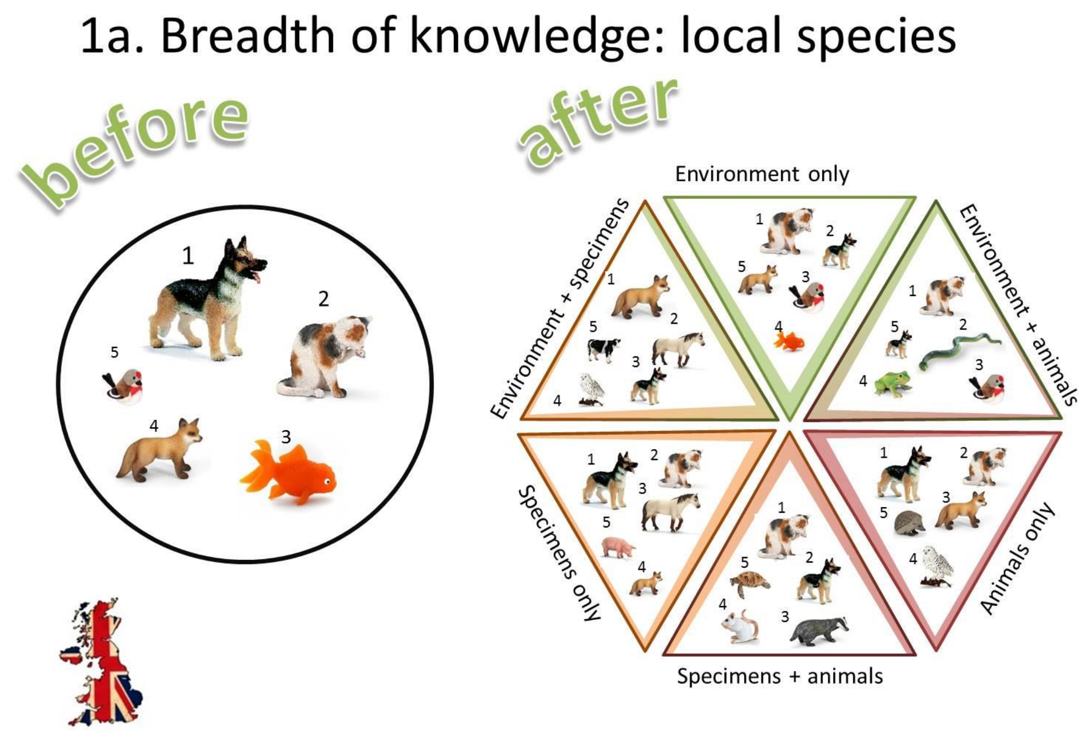


Figure 4.51 Range of local species given in response to the question 'Which local animals or plants do you know about? Write their names or draw'. The top five species which were written or drawn by children are shown in each case. The number next to the animal means how popular a choice it was, with 1 the most popular. Pre-visit responses 'before' are shown left and post-visit responses 'after' are shown right. The Union Jack and UK map motif is not intended to convey a definition of local that extends to the whole of the UK; it is to differentiate this illustration from Figure 4.52, which shows a similar layout but refers to global species. Data are from all pupils.

Figure 4.51 shows that before taking part in an informal biodiversity session as part of this research, the most common local species which children selected was a dog, followed by a cat and fish. Only the fourth and fifth most popular selections were non-domesticated animals.

After taking part in an environment exploration only, the most common species was a cat. One fact to explain this is that there is a cat at Camley Street Natural Park, which the children delighted in seeing, as it strolled in and out of the introduction session. There is no difference in the actual animals in the top five, although the post-visit order is different; cat, dog, bird, fish and fox. Certainly, children saw birds whilst at Camley Street and post-visit interview evidence supports this. The most commonly written example for children who had seen a live animal show was a dog, followed by a cat and a fox. The fourth most frequent was an owl; they saw a White-faced Scops Owl as part of their show. The fifth most popular was a hedgehog, explained by the fact that an African Hedgehog was part of the live animal show. Children who saw specimens only at the Royal Veterinary College were most likely to select a dog as one of the species they knew about. A cat was the second most popular; this order is the same as for the pre-visit results. A dog skeleton is in the centre of the introduction table at the RVC, and there is also a cat skeleton. However, the post-visit order has changed to horse, fox and pig, all three of which were in the Royal Veterinary College as specimens; in particular, a skeleton of a horse is in the central position in the museum.

The most common choices by children who had taken part in an environment exploration and also seen live animals were a cat, snake, bird, frog and dog. The cat was present at Camley Street. Children saw three types of snakes in the animal handling session. They saw land and water birds whilst exploring Camley Street, and this group also saw a frog. For children who had seen live animals and specimens, the most commonly selected species were cats, dogs, badgers, mice and turtles. Children saw cats, dogs, badgers and mice as specimens. The saw a terrapin as part of the live animal show. Children who had seen the environment and specimens more likely to select a fox (seen as a specimen and mentioned at Camley Street Natural Park), followed by a horse (skeleton at RVC), dog (RVC), owl (mentioned at Camley street) and cow (RVC).

There is therefore some evidence that real experience seeing or hearing about a species increases children's recall of that species. The post-visit activities took place in the week following the visits; therefore, long-term recall is a topic for future research.

4.6.3.2 World

Figure 4.52 shows that before an informal learning visit, children were most likely to select a big cat as the species they know most about: lions followed by tigers. Subsequently, monkeys, snakes and elephants are those which children say they know most about.

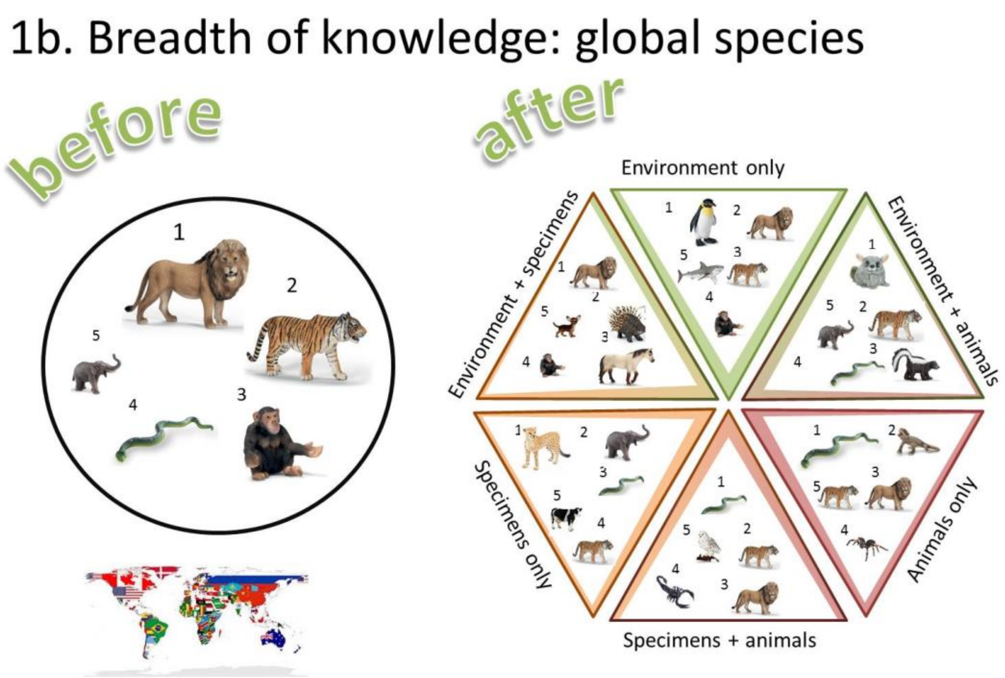


Figure 4.52 Range of world species given in response to the question 'Which world animals or plants do you know about? Write or draw'. The top five species which were written or drawn by children are shown in each case. Pre-visit responses, 'before', are shown left and post-visit responses, 'after', are shown right. Data are from all pupils.

After an environment exploration, class responses changed; they were most likely to select a penguin, followed by a lion, tiger, monkey and shark. The environment centre session did not address global animals; it was about local species. Therefore the reason for this change is not known. Children who had seen live animals were most likely to select a snake as a species they knew about, followed by a lizard, lion, tarantula and tiger. They saw snakes, a bearded dragon and a tarantula as part of the live animal show. Children who had seen specimens on average selected a cheetah, elephant, snake, tiger and cow in that order. All these specimens are present in the Royal Veterinary College museum.

Children who had taken part in the combined session, environment exploration and live animals, selected a chinchilla most often. There was one in the live animal show, which children were allowed to touch. They also saw a skunk (third choice) and snake (fourth choice). A tiger was the second most popular choice, and an elephant was fifth. Children who had seen specimens and live animals were most likely to select a snake, followed by a tiger, lion, scorpion and owl. Again, they saw the lion and tiger as specimens and the other top five as living individuals. There is some evidence of the salience of potentially dangerous species. Children who saw the environment and specimens selected a lion most often, followed by a porcupine, a horse, a monkey and a Chihuahua (all seen as specimens). One of the girls in this group had a Chihuahua at home and spoke excitedly about it to the others, which may have led to the high proportion of children who selected this animal.

4.6.4 Depth of knowledge

Question 2 asked children to select one species to write about in depth. They were allowed to select animals or plants; only two children chose plants (one chose a Rose of Jericho and one a Venus Fly Trap). Their selections, as shown in Figure 5.34, show a range of local and global species. Again, dogs (1), cats (2) and fish (4) are prominent in their top pre-visit choices. This is combined with charismatic megafauna: lions (3) and tigers (5). Did attending informal biodiversity sessions change their choices?

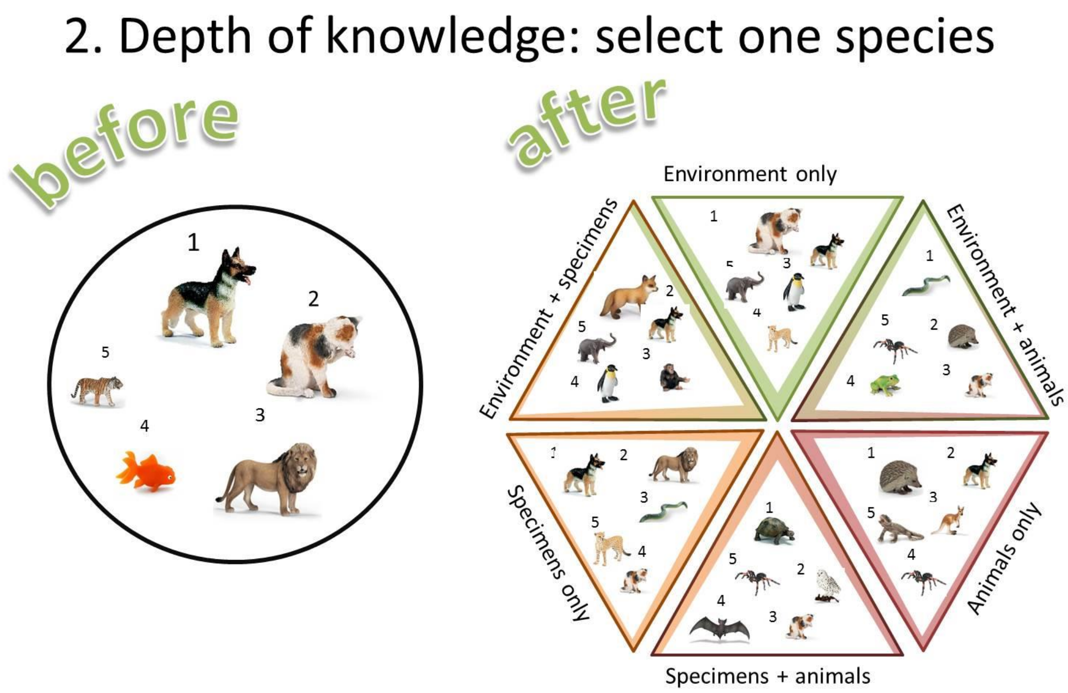


Figure 4.53 Depth of knowledge of animals. This illustration shows children's choices when asked to select one animal to write or describe in detail. Pre-visit responses ('before') are shown on the left, and post-visit ones ('after') are shown on the right. Data are from all pupils.

Children who had attended an environment session only selected cats, dogs, penguins, a cheetah and an elephant (order of preference). Again, the choice of cat may be to do with the fact that a cat was present for this group at the environment centre. The other choices are less easy to interpret. Children who saw live animals only show evidence of having been influenced by the animals they saw in the show (by Animal Man Ltd). The most popular choice was a hedgehog (they saw an African Hedgehog in the show), followed by a dog, a kangaroo, a tarantula and a lizard. Their teacher handled a tarantula, and they got to see a Bearded Dragon lizard up close. Children who saw specimens only selected dogs, lions, snakes, cats and cheetahs in order of popularity. All of these specimens were present at the Royal Veterinary College.

Children who had attended both an environment session and live animals selected animals they had seen most commonly: snake (1), hedgehog (2), cat (3), frog (4) and tarantula (5). They saw all five, alive, either at Camley Street or as part of their Live Animal show. Likewise, children who saw specimens and live animals selected animals they had seen most commonly. The session included a terrapin, and many chose a tortoise. These similar species are often mistaken for each other. The second most popular choice was an owl, and children saw a White-faced Scops Owl in the session. They saw a cat (3) in the Royal Veterinary College; likewise a bat (4). The fifth most popular was a tarantula, which they saw their teacher handle. Children who had attended an environment session and seen specimens selected animals in the following order of popularity: fox, dog, monkey, penguin and elephant.

4.7 Summary

In addressing the question, '*what do children learn about biodiversity in informal learning settings?*' these results have provided evidence that the 180 children who took part in this research made new connections about biodiversity as a result of their informal learning experiences. Their learning can be conceptualised within five domains, as illustrated in Figure 4.54.

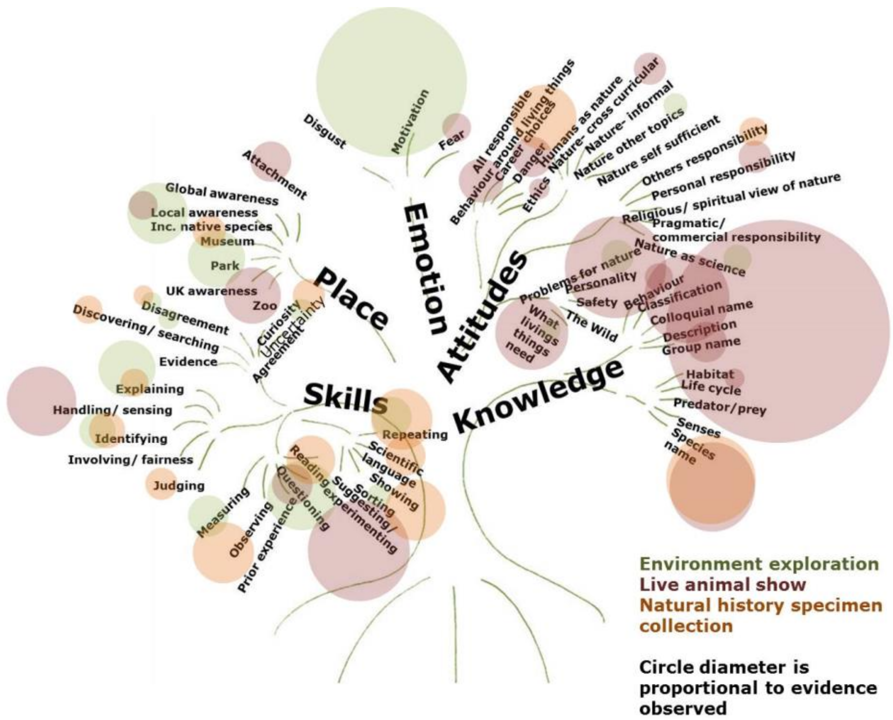


Figure 4.54 The complementary nature of informal biodiversity learning experiences. They shown in the five domains of Learning Skills, Place, Emotion, Attitudes and Knowledge. Environment Explorations are shown in green, Live Animal shows are shown in red, and Natural History specimen handling is shown in orange. The size of the ‘blossom’ or circles on the tree is proportional to the number of responses for that code.

4.7.1 What did children learn about biodiversity in informal settings?

Section 4.1 showed that there is evidence that children do learn in informal biodiversity settings. The majority of responses which evidenced learning were seen in the knowledge domain. The learning code which was most common when all data were considered was ‘species names’.

Children’s learning about biodiversity showed differences according to the setting; environmental exploration developed motivation, questioning and local awareness. Live animal experiences resulted in descriptions, comments about animal personality, and spoken suggestions. On a museum visit children learnt about species names, career choices and developed observation skills. Therefore, there is evidence that different informal settings, which cover the same knowledge goals, are complementary when additional domains (Skills, Place, Attitudes and Emotion) are considered. There is evidence that there are complementary and unique aspects to each setting.

The discussion in chapter 5 will discuss results in detail grouped by informal setting, as opposed to considering them by domain, as this Section has done.

4.7.2 What should children learn about biodiversity outside of the classroom?

Should informal learning experiences prioritise outcomes in the knowledge domain? Do informal learning experiences intend to prioritise this domain? Are educators aware of the balance of learning opportunities that their settings do, and could provide? This is an area for discussion between educators; to understand what their own organisation might provide in terms of intended and unintended outcomes, and to reflect on the balance of activities which children take part in. Figure 4.54 is proposed in this research as the basis for a tool for educators to reflect on their aims for children's learning about biodiversity.

4.7.3 Skill development in informal settings

In terms of skills, I am going to focus on the benefits of handling, sensing and observation as ways to learn about biodiversity. There is evidence that children developed these skills through informal learning experiences, and in the Discussion (Chapter 6) I am going to argue that informal education settings have unique resources to develop these skills, and that therefore the opportunity to develop them should be central to informal biodiversity learning experiences. I will discuss how emotional and sensory information may be involved in making learning more salient.

Within the domain 'Skills', I heard children read labels aloud whilst visiting the museum and environment centre, and I will discuss the ways in which children's label reading in museums and environment centres may differ from adults.

4.7.4 Views of nature

77% of the children were able to draw or write about a natural place that they liked. This ranged from where they lived when they were young to places that they went frequently for sport. Chapter 5 will address their concepts of a natural place, and consider reasons why 23% of children did not have an answer to this question. The domain 'attitudes' showed variety in children's views about responsibility for nature, with the attitude 'everybody should look after nature' being more common after an informal biodiversity visit.

It is clear that pets and charismatic megafauna made up the majority of species which children stated they were aware of pre-visit. I used the breadth and depth of children's knowledge of animal species as one way to gauge their general level of biodiversity awareness. It is clear that some pupils had expert knowledge in this area, and this was not linked to literacy ability. Post-visit, children were more likely to state an animal that they had encountered during their visit. Since this research was initiated, eco-literacy assessment tools have become available. Results from this research will be related to results from wider studied.

The discussion chapter will consider the results from the perspective of each type of informal setting (Environment exploration, Live Animal Shows and Museums), and then cover the following themes:

1. The aims of informal biodiversity sessions
2. Concepts of nature
3. Salient learning about biodiversity.

Chapter 5: Discussion and Conclusions

5.1 Introduction

The research described in this PhD set out to investigate learning about biodiversity in three settings: an environment education session, a live animal show and a museum session. Data were gathered in order to answer the question: *What do children learn about biodiversity in informal learning settings?* This discussion first addresses results per setting, with reference to the literature, in Sections 5.2- 5.4.

In Section 5.5, I will show how the SPEAK (Skills, Place, Emotion, Attitudes and Knowledge) conceptualisation of children's learning (Figure 4.54) can be used as the basis to plan biodiversity education experiences. I will describe how I have subsequently used these five learning domains for evaluating informal education sessions at the Royal Veterinary College in London. Section 5.6 will discuss how children's responses to the research questions bring insight into their emerging concepts of, and attachment to, natural places. Discussion points raised by post-visit interviews with pupils, teachers and informal educators will also be included as supplementary evidence at this stage. Finally, in Section 5.7, I will propose a Salience Theory of Informal Learning, suggesting ways in which children recall experiences more easily when they use sensory skills and stimulate affective responses. This draws on the neurobiology of learning for justification, and is intended as a basis for discussion at this early stage in its formulation. In this section, the initial question 'What do children learn about biodiversity in informal settings?' has started to address how they learn in informal settings, and this area is proposed for further investigation. Section 5.8 will summarise the conclusions of this PhD research and relate it to future areas for research.

5.2 Environment exploration

This Section summarises learning in environment explorations at the London Wildlife Trust's Camley Street Natural Park, next to King's Cross in London. This Section presents results previously discussed in the results chapter by learning domain, but this time the findings are grouped by learning setting. A video still is shown in Figure 5.1 to illustrate the setting.

Figure 5.1 Environmental exploration session at Camley Street Natural Park

Environment exploration sessions aroused *curiosity* in children, as captured both by video evidence and through the post-visit activity question: 'Do you have any questions about your visit?'. This is related to the fact that there was evidence that children acknowledged *uncertainty* about new information or situations. This is included in the Earth Smarts framework as a skill (Nichols and Zeidler, 2012). From a pedagogical perspective, cognitive dissonance between known and unknown is important for attitude change to take place (Izuma et al., 2013); therefore, encountering the unknown could be seen to be a distinctive and important aspect of learning about biodiversity in environmental explorations.

Likewise, *disagreement* and developing a group *consensus* are seen as community skills. This was seen in environmental explorations when children encountered something unexpected, such as an invertebrate, and reacted in a range of ways which revealed their values. For example, some wanted to kill it and stamp on it, whilst others defended it. The resulting disagreement involved backing up opinions with reasons, again a key skill. Amos and Robertson (2012) acknowledge that a benefit of informal learning is allowing conversations that may be curtailed in formal learning environments, using the example of a session with secondary pupils who debated environmental land use near London's Olympic Park.

Environmental educator Helen suggests that the school shapes children's responses to nature as shown in Figure 5.2.

Figure 5.2 Post-visit interview with environmental educator describing the role of the school in shaping pupil attitudes to nature

Children showed evidence of *local awareness*, which was interpreted as naming a local place where they could find wildlife. In response to the question 'Is there a place that you would go to find out about nature?' 69% of the children who had visited the environment centre wrote (or drew) 'park' or specifically 'Camley Street Natural Park', compared to a pre-visit Figure of 36%.

The session format allowed group work, and there were a number of instances of children manifesting the skill of *explaining*. Evidence for this was through video recordings of the sessions. The children enthusiastically took on the role of experts if they had found a living species, explaining how to find it or identify it, or what it was doing.

Environmental educator Helen commented that her favourite part of her job was seeing conversations emerge, as shown in Figure 5.3. In agreement with an initial survey I carried out with biodiversity education providers (Sim, 2011), she considers that the 'real' quality of the environment is important to children; it is what children will speak about. This aspect is considered further in Section 5.7.5.3.

Figure 5.3 Post-visit Interview with environmental educator – children recall real experiences

This relates to evidence of *repetition*. Although the inclusion of repetition as a skill may be considered contentious, I assert that it is a learning skill that children employ naturally to help recall a new word. When analysing evidence, a distinction was drawn between using a new word for communication and simply repeating a new word whilst walking along, for example.

The environment exploration session in this research involved an investigation about hibernation where children had to measure temperature using a thermometer;

there was video evidence that children used *measuring* skills. The introduction and plenary covered issues for wildlife such as cold temperature in winter and lack of food, and children commented on this in post-visit activities in response to the question ‘Do you know about any *problems for animals*?’. The plenary activity also involved *sorting* animals and plants into *producers and consumers*; there was video evidence of this taxonomic skill.

The results have therefore shown evidence for the following themes in environmental education: curiosity and discovery, community skills, local awareness, language development, nature as science, environmental problems and ecosystem relationships.

How do these results relate to the existing literature?

According to Jickling (2005) there is fluidity in the meaning of environmental education, depending on context. A parallel can be drawn with the Red Queen concept, which will be familiar to many ecological researchers (you have to keep running to keep pace with competitors). The parallel lies in the fact that the meaning, content and process of environmental education has to keep changing, in order to respond to ever changing social, political and environmental factors. To explain this further, curiosity and discovery are central to exploring the environment, and it could be said that these skills would remain fairly constant over time. Children explore the outdoors, are excited, and seem to feel rewarded by finding out new information.

However, the theories and ideas behind environmental problems and ecosystem relationships are evolving themselves and being updated, based on scientific, social and geographical research; this then informs policy. At the same time, community skills, local awareness and language development have become more pertinent as societies have diversified. A key theme to emerge at both the ‘Science across Cultures’ conference for science centres (2011) and the World Environment

Education Conference (2013) is the balance between rational, scientific, decontextualised approaches and understanding local community interpretations of meaning (Stevenson and Dillon, 2010).

Informal learning practice and theory includes a semantic debate about the terms 'learning' and 'education'. Would it matter whether this Section is called Environmental Learning or Environmental Education? For example, Jickling and Wals (2013) do not think that learning is a richer concept than education. However, this question of precise wording and scope of definition would certainly be enough for a difference in meaning to be construed in UK museums. Learning is seen to be more contemporary in informal teaching. The use of the term 'Learning' was very popular under the Labour government (1997-2010); 'Learning' is perceived to be more pupil-centred. However, the Coalition government in England has favoured Education, as in 'The Department for Education'. Writing as I am, from the Institute of Education (why not the Institute of Learning?) I am hesitant to argue against this word in terms of the communication properties it lends.

An alternative viewpoint is proposed by Le Grange (2013) who suggests that 'learning' has led to a commodification of the education process, with the learner seen as a consumer of a product. I would argue that this proposal needs to be considered for informal teaching, not only because parents or schools sometimes have to pay for the experience and in this way they are consumers with all the features that brings – expecting high quality, choice, convenience etc. Le Grange acknowledges that there are often unintended outcomes for learners after educational experiences. This raises the question: to whom are they unintended? Which stakeholders? The unintended outcomes may be the most interesting part for researchers (as opposed to evaluators). Le Grange goes on to take the position that using the word 'education' allows understanding of the fact that meanings are co-constructed, although his arguments for this are not entirely convincing.

This Section is intended to acknowledge that there are debates in informal education/learning about the relative merits of those terms. I agree with Le Grange's point that 'the lexicon of Environmental Education is important' (2013:109). My research takes the position that both 'learning' and 'education' are useful as communicative tools and are associated with the chosen vocabulary of the prevailing governance system. They therefore need to be attended to in order to align teaching about nature strategically with policy initiatives. I think this is something that is too often missing from the environment education research debate: acknowledgement of the fact that environmental education does not take place in a milieu overflowing with ample funding to enact the latest theories of biodiversity education research. More understanding or credence should be given to the educators who must take decisions to bring people in through the door. In addition, many educators who work in environmental settings do not necessarily have backgrounds in this area. An interview with the environmental educator shows an example, in Figure 5.4.

Figure 5.4 Informal educators do not necessarily have backgrounds in the field of environmental education

From the environmental educator's perspective, the issues in environmental education are at a practical level, as described in Figure 5.5.

Figure 5.5 Practical issues in environmental education

Environmental educator Helen describes issues in environmental education from her perspective. The temperature, the time and the presence of animals are aspects that she considers are important to ensure a good visit. The relationship between theoretical perspectives and the constraints to carrying them out is an area for further research.

This has been a useful aspect of this research, to draw out the areas of similarity and difference between traditions which apparently teach the same topic. This is a basis for understanding what these traditions can learn from one another.

The next Section will look in detail at the second setting, live animal shows, and link results to current literature.

5.3 Live animal shows

This Section summarises learning about biodiversity by eight and nine year olds at live animal shows. It presents results previously discussed in the results Section by learning domain, but this time the findings are grouped by learning setting. Figure 5.6 illustrates a live animal show.

Figure 5.6 A pupil handles a tarantula at a live animal show

The sub-domain ‘personality’ refers to children *anthropomorphising* animal behaviour, such as referring to an individual animal’s name or how it behaved. This is contentious in zoo education, as it is clear that children empathise with animals’ characters, and this positive association would be considered beneficial for the overall goals of promoting an interest in conservation of those species. However, an overly sentimental attachment to individuals is not always consistent with a scientific view of biodiversity. For example, children may interpret animal intentions anthropocentrically, such as thinking that animals want to live in similar size family groups as humans, and have similar social patterns. This does not help with understanding the relationships in an ecosystem in the long term.

Figure 5.7 shows Live Animal Educator Stuart explaining his view on the relationship between human and animal behaviour.

Figure 5.7 Live animal show presenter describes personification

Live animal educators often look after their own animals and develop a strong emotional bond with them, comparable to the relationship between people and their pets. The effect of this human-animal bond on the educational experience for pupils would be a topic for further research; for example, one could compare the learning by children who attended a live animal show where presenters did not personally look after the specific animals (e.g. at a large zoo) with a show where the presenters were responsible for animal care personally.

This relates to the fact that children had a number of *ethical questions*, such as 'How did you get the animals?'. There is a narrative about not taking animals from the wild; yet the animals that the children can see have clearly been removed from their habitat but by experts who are able to care for them using specialist knowledge. The emphasis on care, told by the presenter who was personally responsible for the animals, may be the reason that children who had seen the live animal show were more likely to respond 'us / we should / I should' in response to the question 'who should look after nature?' post-visit. This was recorded as the attitude sub-domain *Personal responsibility towards living things.* Children were also keen to know about the life cycle with reference to individual animals – such as how old they were and if they had any young.

The format of live animal shows allows children to suggest reasons for features or adaptations, and there was video evidence that children were making new associations by *using prior knowledge* to suggest reasons for their observations. Figure 6.8 shows live animal show presenter Stuart explaining that children often comment on their prior experiences of seeing an animal.

Figure 5.8 Post-visit interview – how children use prior knowledge in conversation at live animal shows

The presenter *classified* each specimen, stating whether it was a vertebrate (there were birds, mammals and reptiles) or invertebrate and why. There was evidence that children had learnt about the definitions of these *categories*, as well as evidence that they had learnt group names. There was video footage of children handling animals during the show. This relates to the attitude code of *being kind to animals*; children commented to each other about being quiet and not frightening them. There was a change in perception throughout the show from seeing the living animals as *dangerous or venomous to behaving gently*, acknowledging that the animals could be intimidated by humans as well as the reverse. This is consistent with findings by Randler et al. (2012) that fear in children is a survival mechanism, but can be reduced through activities which challenge initial biases. The sub-domain 'danger/venomous' was added as an attitude to code certain of the conversations that took place between children observing live animal shows, likewise fear. When asked 'is there a place that you would go to find out about nature?', children who had seen live animal shows frequently drew zoos, typically London Zoo. After their visit, children who had visited this session were more likely to answer 'literacy' in response to the question 'which lesson would teach you about nature?' (open-ended response). Figure 5.9 shows a class teacher commenting on the impact of meeting live animals on children's writing, particularly for lower ability writers.

Figure 5.9 Post-visit interview: impact of meeting live animals on children's writing

The presenter used a number of links to popular culture – TV shows, film and stories – which could be a reason why the children saw the experience as *narrative- / media-related.* The results therefore provide evidence for the following themes in zoo education: anthropomorphism, ethics, responsibility for nature, prior knowledge, classification/categorisation (taxonomy), animal welfare, change in attitude with relevance to fear, attachment to zoos, and media links.

Figure 5.10 is from a post-visit interview with live animal presenter Stuart, where he explains the benefit of meeting live animals compared to seeing them on a screen.

Figure 5.10 The benefit of encountering live animals

How do these results relate to zoo education literature?

Using Patrick and Tunnicliffe's analysis of talk at live animal exhibits (2013; see Chapter 2), I found level 3 patterns of interactions when observing video evidence provided by children during the informal sessions. In contrast to studies which have been carried out with family groups, I found that peers frequently took on the role stated for an adult in level 3 interactions, i.e. child 1 - child 2 - child 1, consistent with Ash's (2007) research on Thematic Continuities. She found that children try out ideas by making statements which they test with peers, and become expert through a cycling process where the key words remain the same but the pronouns and articles around them are modified.

Patrick and Tunnicliffe (2013) categorise the content of children's conversations in informal biodiversity learning settings, although their conclusions are based on museums and zoos rather than environment centres. They suggest four types of content:

1. Access – making sense and finding something to look at.

In my experience these comments tend to be imperative: 'look!'. Hensel (1987) comments that these instructions can also be used to manage the group, as something to attract the group's attention.

2. Focus – observing the structure or behaviour of specimens or animals and categorising the observations.
3. Management – organising the group and directing behaviour.
4. Social interactions.

It would have been possible to analyse evidence gathered in this study in terms of these categories by assigning numbers (frequencies of occurrence of categories) to transcripts of conversations. The process I went through to elucidate the code for the SPEAK conceptualisation was similar to that but used the Earth Smarts' framework (Nichols and Zeidler, 2012) as a basis for analysis, for reasons already given.

When considering work with live animals, it is important to acknowledge that there are viewpoints opposing animals in zoos (e.g. Kiley-Worthington, 1990), and there is a distinction between zoo organisations that prioritise profits from charismatic megafauna (Baratay and Hardouin-Fugier, 2004) and those that prioritise long term species conservation. There is a widely held belief amongst zoo educators that the opportunity to observe an animal's behaviour can help people to start to care about conservation (Kiley- Worthington, 1990). However, Vining (2003) explains that she did not find conclusive evidence to support this link in her paper, although she asserts that forming emotional connections is key to the psychology of future positive actions. Figure 5.11 shows Live Animal Educator Stuart's viewpoint: he explains the link between zoos and conservation.

Figure 5.11 Justification of animals in zoos

Vining's research findings are consistent with those of Patrick and Tunnicliffe (2013), who considered animal exhibits, both living and non-living, and found that visitors' interactions with live animals are shaped by:

1. Pre-existing attitudes towards animals, knowledge of animals, and experience with animals
2. The emotions the exhibit arouses in the visitor
3. The senses the visitor uses whilst experiencing the exhibit
4. The animal's visual impact
5. Reactions of the other members of the visiting group
6. Whether the animals are living, non-living or preserved
7. The number of specimens and the visitors' ability to see them
8. The psychological involvement required by the exhibit
9. The conversations that take place within the exhibit.

(2013:86)

Some of these themes clearly share elements with those one would expect at museum exhibits, and will be extended in the following Section about animal specimens. The difference in emotional responses to living and non-living things is an area which will be further considered in Section 6.6, looking at the salience of informal learning.

5.4 Natural history specimen collection

This Section summarises learning in museum specimen sessions at the Royal Veterinary College site in Camden, London, UK. It presents results previously discussed in the results Section by learning domain, but this time the findings are grouped by learning setting. Figure 5.12 shows the plenary session at the museum at the RVC.

Figure 5.12 Plenary session at the RVC museum

Career choices were key learning outcome for children in the specimen collection session; the introduction included a discussion about the purpose of the collection and the educator asked children who might use the collection. This lead to a conversation about jobs, providing video evidence for this new attitude sub domain: ‘Career choices’. Natural history collections often include specimens that were originally collected for non-scientific purposes, such as hunting, souvenirs or clothing

(Atran, 1993). They continue to be used for scientific enquiry, and the narratives introducing the collection therefore included reference to the types of science that might need to use real artefacts, as a justification for the collection. In this particular session, the clear explanation at the start of the session meant that there was little evidence of questioning about why the space contained dead animals; however, personal experience suggests this is unusual. Figure 5.13 shows educator James explaining children's responses to dead specimens.

Figure 5.13 Explaining specimens in museums

Video evidence showed children using skills of *observation* (prompted by a worksheet) to identify species, such as looking at claw sheaths to tell the difference between a canine and a feline. In video evidence children can be seen and heard to *show* other children where particular specimens were, once they had found them through free exploration. A typical phrase was "Look! It's the cheetah!".

The children can be seen and heard to *read* labels. Museums are not frequently pitched to teachers as contexts for developing reading skills in children. Children were heard to use specific new *vocabulary* such as habitat types and adapted features (e.g. beak, hooves and spine). Similarly to the environment exploration, they had the opportunity to freely explore, find new species that they didn't know, and *identify* them through a discussion process which often involved disagreement.

The skill sub-domain *discovery/searching* was recorded when children were observed on video to actively engage in sustained seeking activity.

When asked 'Is there a place that you would go to find out about nature?' 26% of the children who had visited the specimen collection wrote or drew the Royal Veterinary College *Museum*, compared to 2% suggesting a museum in the pre-visit activity. An unexpected outcome of the session was the fact that the most common post-visit response to the question 'Who should look after nature?' referred to someone *other* than the child, for example, "people who care about nature", "scientists", "vets" and one child stated "a better government"!

The results have therefore shown evidence for the following themes in museum education: observation, reading, language development, identification, discovery, attachment to museums, and others' responsibility for nature.

How do these results relate to the literature?

Data were consistent with patterns of children's behaviour observed by other researchers in the field, for example McManus (1987), who observed the following visitor-exhibit interactions when looking at animals: visitors either walk past, make a comment, explore the exhibit, or study it for a sustained period of time. These types of activity can be seen clearly in video data. Figure 5.14 describes McManus' (1987) classification of visitor behaviour more fully.

Category of behavior	Action	Interaction with exhibit
Walk past	Minimum interaction or ignore	No interaction
Passing comment	Walk by but remark on some feature	Slight interaction, some use of message displayed
Explore	Stop and interpret features using own experience and that of experts	Direct interaction by talking, touching, and seeking a response; aware of noise and smell of exhibit
Study	Stop and interpret using the message of the exhibit, everyday experience, and expert knowledge	Mental interaction—show and tell, re enact or teachback

Figure 5.14 Interactions at museum exhibits (McManus, 1987)

However, there were also surprising findings which were not consistent with other researchers' finding, as discussed below.

5.4.1 Do children read more labels than adults?

Patrick and Tunnicliffe (2013:62) state that 'direct reference to labels is not a prominent part of the conversations'. However, I found that some children did attend to the labels, sometimes for extensive periods of time. This is in contrast to adult behaviour around exhibits as documented by Hooper-Greenhill (2013), who states that there is a low dwell time; it may only be a few seconds (Porro and Cerri 2013), depending on the audience member and exhibition subject. From previous personal teaching experience, the way in which children read the labels (aloud, hesitantly) was consistent with behaviours of learning to read. I was surprised by the amount of reading the children chose to do, and future research could compare children's and adults' reading time at labels. Exhibition designers may not realise the extent to which children sometimes attend to written information. Figure 5.15 shows Museum educator James explaining that Student Ambassadors support children in reading at the museum.

Figure 5.15 Post-visit interview: reading in the museum

5.4.2 Identification

Hoage and Deiss (1996) found that 'The conversations that take place between children and their accompanying adults frequently consist of naming individual animal specimens'. I would go further to say that I saw evidence of this between peers, as well as in child-adult interactions; again, this is consistent with work undertaken by Ash (2007) about thematic continuities in children's conversations. Why is naming species important? I assert that there are two reasons. One relates to the child's development and the other to socioecological literacy (to use Nichols and Zeidler's concept, 2012).

In order to understand its potential significance for child development it is necessary to consider what is involved in identifying an animal independently. First, the child has to see an exemplar. This would be an example of an association between a set of sensory stimuli and a verbal label. To start with, any of the stimuli might be considered critical to be associated with the label, but repeated experience hones the exemplar so that children's understanding of a concept gradually aligns with accepted viewpoints in the culture or knowledge tradition within which they are operating. For example, a child might see a stuffed fox in a museum and associate the following characteristics: 'orange, furry, dog shape, whiskers, ears, four legs, still, makes no sound'. Then, they might see an image of a fox which is 2D. It would have the features 'orange, dog shape, ears'. They cannot feel the fur, and may not be able to see any artistic texture relating to fur. Four legs may not be visible. They then see a fox near their house. This time, it is manifested by 'orange, dog shape, whiskers, four legs, ears, moving, and bark sound'. It is clear that learning names of animals involves considerable processing in terms of filtering out features which are not consistent, and appreciating those that are. This is all without confounding aspects such as changing ambient light (alters colour) and different life stages of the animals (different appearance, same label in some cases). McCloskey and Glucksberg (1978) comment that animal naming has many 'fuzzy sets', e.g. a dolphin looks like a fish but is a mammal. Therefore, learning animal names and categories is a model for learning concepts in other areas, and one which is frequently used with young children.

In terms of socioecological literacy, the importance of understanding ecosystem components as a prerequisite to systems thinking is strongly supported in the literature (e.g. Barker and Slingsby, 1999; Peacock, 2004). In order to work in certain scientific fields identification is an essential skill.

A school of thought exists (evidence: personal experience in museum practice) that considers it poor practice to encourage children to label specimens, as it closes down exploratory conversation. However, I assert that it is essential that children leave an interaction about a live animal or specimen with the vocabulary they need to communicate what they have learnt to others, which includes the accepted label (i.e. name) of that live animal or specimen.

5.4.3 Prior knowledge

The results I obtained show evidence of pupils using their previous experiences in new circumstances. This is consistent with Baratay and Hardouin-Fugier's (2003) assertion that popular culture contributes to prior knowledge about zoo animals, and Falk's (2011) work showing the landscape of informal science experiences which people experience (see Figure 2.3). Patrick and Tunnicliffe (2013) support this assertion referring to zoo visitors; they consider that a thorough understanding of learners' prior knowledge is necessary for zoo educators.Children get information about animals from direct representations (objects and images – stuffed toys, books, specimens, books, television, internet, classroom decorations) (Atran 1993) and from their culture, community, family, friends and personal encounters (Xuehua, 2004). Bruner (1983) stated that children's personal experiences with animals allows them to notice physical features and sort the animals. Mothers also play a role in the early naming-selection filter (Markman, 1989). Likewise, Wagoner and Jensen (2010) state:

> The cultivation of pre-representations of animals, habitat and the environment occurs over an extended period of time through the influence of multiple sources, including formal education and the mass media. Education within the zoo must interact with such pre-existing ideas in the process of visitors' development of a new understanding of animals and their environments
>
> (2010. 73-74)

Patrick and Tunnicliffe (2013) classify visitors' prior knowledge:

1. Understanding of the term 'animal'. Importance: identifying animals on IUCN Red List for example (Crisci et al 1994). They develop vocabulary and naming skills, but this is not Linnaean (Hoage and Deiss 1996).
2. Comprehension of a layman's taxonomy. Most visitors can't group animals scientifically but knowing features is key to understanding physiological and ecological importance. Example: grouping by integument (animal skin surface).

3. Perceptions of animal behaviour and anatomy
4. Curiosity about individual animals
5. Emotional connection to animals
6. Cultural understandings of animals. (2013:71)

Their evidence comes from clarifying connections between comments and understandings expressed to others, giving insight into visitors' mental models. Figure 5.16 shows a still from a video recording made during a museum trip at the RVC. On seeing the elephant, children can be heard to say 'Dinosaur!'. This is because previous experience of seeing a large skeleton would have been seeing a dinosaur skeleton. Pupils' categorisations of extinct and extant species and their relationship to skeletal structures is in a developmental stage at age 8.

Figure 5.16 Pupils see an elephant skeleton at the RVC

Figure 5.17 shows a post-visit interview where James explains this common misconception.

Figure 5.17 Post-visit interview: the difference between skeletons and dinosaurs!

The next Section will describe how information about what the children were observed to learn can be used as a tool for reflection, and how it has been used to evaluate informal learning sessions at the Royal Veterinary College in 2013.

5.5 Planning biodiversity education experiences

The previous Sections have linked observed learning in different settings to the themes of environmental education definition, learning conversations in zoos and museums, and the importance of animal identification. When considering what children should learn in biodiversity education activities in England, the National Curriculum provides guidance about the skills and knowledge which pupils are expected to cover. However, this research showed that there is evidence of learning in other domains (Place, Emotion and Attitudes), and an important part of this research is to highlight these inadvertent aspects of learning. This Section will consider to what extent learning should be planned to take into account learning in affective domains and about place.

In museums, guidance about the Generic Learning Outcomes (see www.inspiringlearningforall.gov.uk) led to a shift in thinking about planning and evaluating informal learning, to include domains such as ‘enjoyment, creativity and inspiration’ as well as the formal domains of ‘skills’ and ‘knowledge’. However, in zoos and environmental settings (at the time of writing) there has not been a similar paradigm shift in thinking about planning education sessions.

The aim of planning activities to take into account non-formal domains would be to acknowledge the unique opportunities afforded when children visit a novel environment, with new resources which offer the opportunity for new sensory stimulation. Taking into account non-formal domains would provide support for informal educators to plan sessions which make use of the distinctive aspects of their setting, rather than just considering which aspects meet the aims of the National Curriculum’s generic examples. At the time of writing, the English science National Curriculum has recently been reviewed, and includes teaching about evolution at upper key stage 2, for first teaching from September 2014.

5.5.1 Goals of Biodiversity education

It is a useful exercise to start to consider the links between observed learning and goals. Returning to literature covered in Chapter 2, the goals of environmental education include understanding ecosystem inter-relationships and the interaction between humans and the environment. They may include developing positive associations with the environment, and more recent definitions include multiple perspectives on environmental issues (see for example Sauvé, 2005; Palmer 1998; Stapp, 1969).

The idea that attitude change should be an outcome of informal biodiversity learning is a central tenet of antipodean approaches to biodiversity education. For example, Alastair Stewart (2011) describes the pedagogy of Australian natural history. In 2011, I travelled to Australia and New Zealand as part of a Winston Churchill Memorial Trust Fellowship, and met people in environment centres and zoos who were passionate about the importance of communicating how to live sustainably. For example, I spoke with Pat Spiers at the Field of Mars Environment Centre, who teaches children to see how environments have changed and can change in future. At Auckland Zoo, Caroline Thalund, Visitor Experience Manager, and Monica Zwartz, Head of Education, spoke about the importance of their Palm Oil campaign. They linked an in-depth project about habitat conservation in school grounds with international themes of habitat destruction, and showed children how they could make sustainable purchasing choices in supermarkets. Behaviour change outcomes in museums tended to focus more on developing a relationship with the museum, and visitors attending future related activities.

Heinlich, Mony and Yocco (2013) researched belief systems, and think that one aim of environmental education should be to elucidate children's values and belief system and align them with pro-environmental behaviours. Patrick and Tunnicliffe state that "The outcome of a zoo visit is situated in the affective domain of learning, the domain concerned with emotions, feelings, beliefs and attitudes" (2013:46). I would instead suggest that there are several outcomes and those skills and knowledge outcomes, as appropriate to context, are also important.

Zoos have competing goals of access to animals, research and public education (Spicer, 1994). I would add entertainment and conservation to these goals. Museum goals veer between curation and public education about their collections and their relevance (Hooper-Greenhill, 2013). Figure 5.18 shows museum educator James describing his goals for the session.

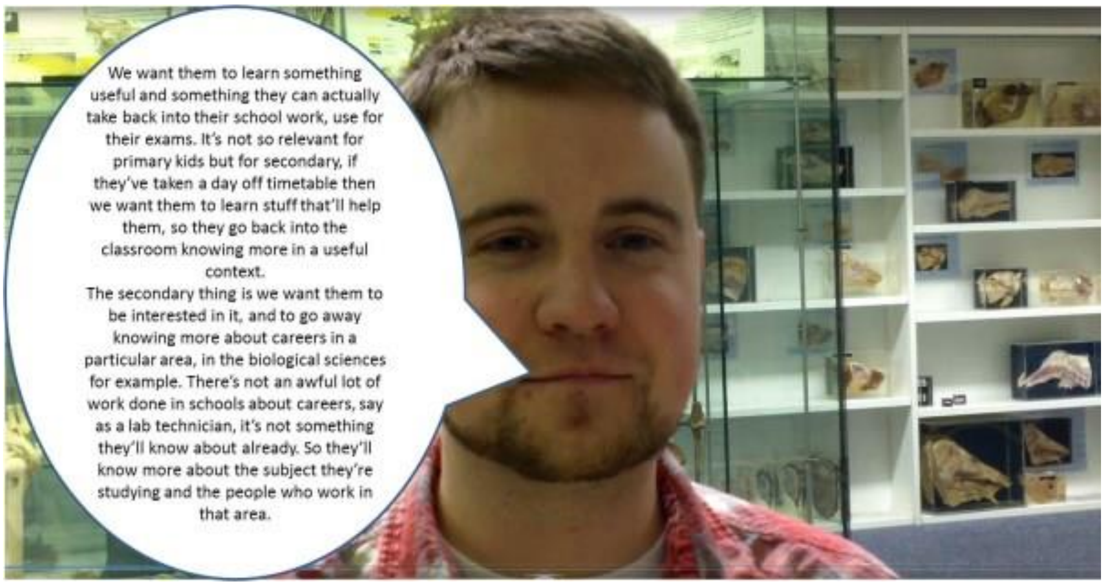


Figure 5.18 Goals of a museum session

The perspective in Figure 5.18 corresponds with pupil learning observed in the museum sessions, in that there is an emphasis on knowledge and careers. However, the goals of teaching about biodiversity vary according to context.

Goals of education about nature have been linked with global policy since the 1960s, as natural resource use has become an increasingly important topic. Linke (1980) cites the IUCN definition:

> Environmental education is the process of recognising values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness among man, his culture and his biophysical surroundings. Environmental education also entails practice in decision-making and self-formulating of a code of behaviour about issues concerning environmental quality.
>
> (1980:26)

More succinctly, Lucas' well-known quotation states that education about nature should be "in, about and for the environment" (1979). Gough and Gough (1994) point out that there was an assumption that there is correspondence between experience and resultant behaviour. Howe and Disinger state:

> The bottom line purpose of environmental education in the view of most of its supporters and many of its practitioners is the development of responsible individual and societal environmental behaviour.
>
> (1991:5)

This builds on work by Hungerford and Volk (1990:8): "The ultimate aim of education is to shape human behaviour". They go on to define an environmentally responsible citizen:

> One who has (1) an awareness and sensitivity to the total environment and its allied problems [and/or issues], (2) a basic understanding of the environment and its allied problems [and/or issues], (3) feelings of concern for the environment and motivation for actively participating in environmental improvement and protection, (4) skills for identifying and solving environmental problems [and/or issues], and active involvement at all levels in working toward resolution of environmental problems [and/or issues].
>
> (1990:8)

Huckle (1991) likens the refocusing on values to an evangelical mission. Previously, Huckle (1983) had asserted that values education is a product of a liberal philosophy which focuses on the social and political needs of the individual but ignores the political context. I disagree, as values education must take place within a political context which intrinsically affects how values are presented. Kollmuss and Agyeman (2002:240) use the term 'Proenvironmental behaviour' to refer to someone who "consciously seeks to minimise the negative impact of one's actions on the natural and built world". Jensen (2002:326) adds: "an action is targeted at a change: a change in one's own lifestyle, in the school, in the local or global society". UNESCO (2004:41) meanwhile acknowledges the "multiple connections between the changes, values, practices, behaviours and relationships which sustainable development implies". New directions in research are multivoice, and respect indigenous viewpoints. However, in reality, education about nature struggles to explore values and a multiplicity of viewpoints: “practical recommendations can effectively close down discussion of those issues” (Foster and Hammersley, 1998:621).

The sessions observed in this research did not allow time to explore values development and attitude change explicitly, although messages were conveyed implicitly, for example, ‘who should look after nature?’.

How many informal educators reflect on the goals of biodiversity education? If they have a background in environment education they will be aware of the literature; however, there are many entry points to jobs in informal learning, and it is possible for someone to teach a regular session without having thought about the underlying reasons for different activities.

5.5.2 Reflection on the goals of biodiversity education

How should educators balance the goals of their field, organisation, unique setting and curriculum aims when planning practical teaching activities? The SPEAK conceptualisation of biodiversity learning is proposed as a tool for reflecting on the goals of informal biodiversity education and time spent on practical education activities carried out by an organisation. I propose that a useful activity for informal educators would be to use a tally chart similar to that shown in Figure 4.2b, to record evidence of learning under the different activity codes. Using this as a basis for planning, and then documenting learning, for example using iPads as described below, would bring insight into the impact of learning activities.

5.5.3 Developing the SPEAK conceptualisation of learning

As part of developing the SPEAK domains of learning, a pilot study was carried out by two PGCE students (Alice Lapinskis and Georgina Keeler) from Exeter University in May 2012 at the Natural History Museum. Observing the sessions ‘Dino-Scientists’, 'Mary Anning gallery character', 'Cutting Edge' and 'Investigate', they found evidence of learning as shown in Figure 5.19. All sessions were conducted with a class of Year 3 pupils. The PGCE students recorded a mark on a tally chart each time clear evidence was seen to indicate learning in the four domains (at this point in the research, the domain 'emotion' had not been specifically delineated).

Across all sessions, more opportunities for local and global awareness could be provided as a means to relate learning to pupils' wider understanding of place. There are a number of observations in this Figure which could be further investigated; for example, it appears from this limited sample that there was more evidence of motivation when gallery characters or informal educators led sessions, compared to a self-guided activity. In addition, the workshop-style activity resulted in the highest evidence of use of specific language.

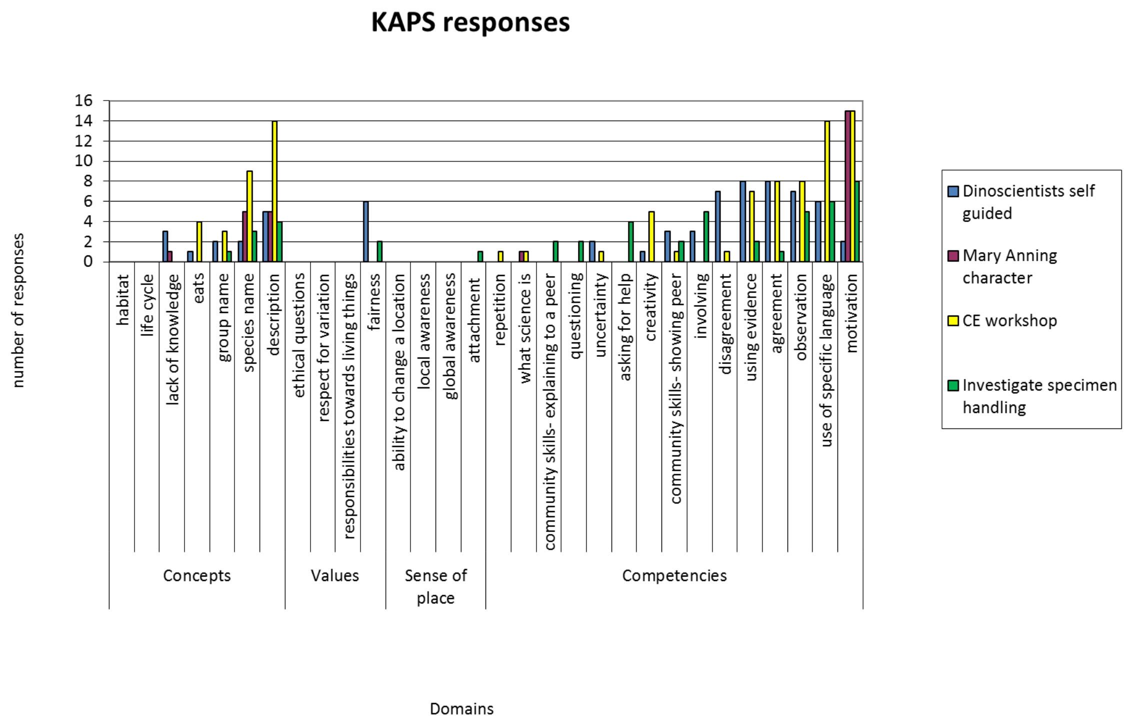


Figure 5.19 Pilot use of Skills, Place, Attitudes and Knowledge as domains to understand pupil learning. This research was carried out by PGCE students Alice Lapinskis and Georgina Keeler from Exeter University in May 2012.

I propose that stakeholders from an organisation, e.g. managers, informal educators, volunteers and teachers could observe the sessions they usually teach, either when another educator is leading the session or by video, to reflect on children's learning. This would raise areas for discussion such as the pedagogy, proportion of time allowed for conversation and activity, and the goals of the session.

Realistically, the content and schedule of informal education sessions can arise by trial and error, teacher request or tradition, as demonstrated by the informal educators' reflections on programme development shown in Figures 5.20, 5.21 and 5.22.

Figure 5.20 Environment exploration programme development

Figure 5.21 Live animal show development

Figure 5.22 Specimen collection programme development

Sessions often arise organically, from a pre-existing structure, rather than having pre-determined aims. Observing sessions using this framework for reflection would allow insight into intended and unintended learning outcomes, and may provide evidence to update the session content.

5.5.4 Using SPEAK with iPads to document learning

In September 2013 I started full-time employment at the Royal Veterinary College as Outreach Development Manager. In this work, I have used the SPEAK domains to plan and document evidence for learning in the informal learning sessions 'Afternoon anatomy', using iPad software. This is a mechanism for communicating the value of informal learning activities for children to schools and parents, as shown in Figure 5.23.

Figure 5.23 SPEAK used on iPads. The teacher tags the pupil's name (in order that a personalised report can be collated automatically for an individual at the end). The informal educator or teacher can add objectives which have been met

The domains allow communication of both formal objectives and informal aspects of learning. I have presented this work at a meeting for access to higher education staff, and there has been some interest in using this method for communicating the impact of a visit to a university or college. I propose that a similar scheme could be used for zoos, museums and environment centres.

5.5.5 Implications for educators

What should learners take away from their experiences? Figure 5.24 shows a teacher explaining her viewpoint in a post-visit interview; she argues that nature is a motivating way to learn about science. However, what recommendations do informal educators and teachers make to improve biodiversity education? Figures 5.24- 5.27 show a range of perspectives.

Figure 5.24 A year 4 teacher's view; nature is a motivating context for science

Figure 5.25 Environmental educator's view on curriculum change

An environmental education perspective is that the affective quality of appreciating the natural environment is critical, given the paucity of natural places.

Figure 5.26 A teacher's view on the importance of making the environment interesting

The teacher's view shown in Figure 5.26 supports the need to make biodiversity education as 'real' as possible, to allow children to experience living things, given their lack of prior knowledge. This viewpoint is similar to the recommendations given to improve biodiversity education in the initial survey I carried out with biodiversity education sites (Sim, 2011).

Figure 5.27 Museum educator perspective on improving biodiversity education

In Figure 5.27, James takes the view that teachers do have access to good resources, but don't have/make time to maximise the opportunity to use these. This may be due to a number of factors, not least the availability of local CPD to show teachers routes to access real experiences for children. In addition, he highlights the problem of transition, that children's inquisitiveness is reduced in secondary school, that things they enjoyed in primary are no longer attended to.

From a zoo education perspective, Patrick and Tunnicliffe suggest:

> The role of classroom and zoo educators is to broaden children's visual perceptions of animal diversity to and provide animal names and groups, with the goal of leading children to an understanding of zoological taxonomy.
>
> (77:2013)

This is a scientific perspective, and relates to the learning process of categorisation outlined above. Wals and Dillon (2013) assert that there are both instrumental and emancipatory approaches to designing environmental education. The question 'What should we be developing in learners?' is instrumental, whereas 'How can we create optimal conditions and support mechanisms which allow citizens, young and old, to develop themselves in the face of change?' is emancipatory.

Returning to the results Section, when considering how to use the SPEAK tree conceptualisation as a tool for reflection on an organisation's goals for teaching. It is important to be careful when considering what learners 'should' know. I intend to use it by appealing to the viewer to see the negative space, to look and see what is not currently there. It is important to engage in a process of critical reflection and think about what is not represented on that tree, rather than what is. For example, looking at a blank version of the tree , where are environmental economics represented? How about resource use?

Lundholm et al. (2013) note that individualisation and globalisation have led to insecurity and unpredictability. They posit that the sort of learning needed should be:

- Transdisciplinary
- Transformative
- Crossboundary
- Action-oriented
- Social.

They use the term 'transperspectival' to encompass the cross-disciplinary viewpoints and nature of necessary learning. They state that "Learners need to be self-reflexive and willing to change beliefs" (2013:243). A number of works from the field of environmental education support the assertion that learning about nature should be social (Wals, 2007), participatory (Reid et al, 2008), culturally situated (Stevenson and Dillon, 2010) and should develop resilience in learners (Tidball and Krasny, 2011).

Lundholm et al. (2013) also suggest that future research into the learning process in environment education settings should represent the learner's voice in order to understand their thinking, rather than measuring outcomes. This thesis' research has included both learning differences and qualitative research via interviews with pupils, but future research could actively involve pupils as researchers.

Kyburz-Graber (2013) suggests that commonly agreed knowledge is rare in the face of pluralism, referring to the transperspectival approaches outlined above. I am cautious about this claim; I feel it takes an extreme position, albeit that this is often necessary to influence prevailing viewpoints when an idea is novel. For example, in the field of medical education, commonly agreed knowledge is essential for conducting operations. However, in the field of environmental education it is clear that social context and multiple viewpoints are becoming key considerations (Stevenson and Dillon, 2010). Kyburz-Graber suggests that the pedagogical position is that knowledge transmission is replaced by constructivism. I would go further to say that I have not come across any theoretical positions that advocate knowledge transmission as a preferred pedagogy in recent years. However, examining that in further detail, how does this relate to what happens in practice? As described, the normative practices of museums, environment centres and zoos do include some level of knowledge transmission; in order to assign a name to an animal, at some point knowledge transmission has to take place. In addition, repetition of key vocabulary can be useful for pupils in order to learn words (DfES, 2003). I would caution against taking a stance which entirely criticises knowledge transmission, but instead see a range of teaching approaches as suitable according to context. On the topic of the 'best' teaching approach, Kyburz-Graber explains:

> Claiming that learning is an open and constructive, active, critical and reflective process asks for a sceptical position against every attempt to prove evidence for 'best' educational approaches. Rather, it has to be assumed that environment education pedagogy is highly contextual, depending on teachers and students previous experiences, on their local environments, school culture and current societal trends.
>
> (2013:26)

This explains why some people are against the concept of 'best practice' in principle, as if best practice was a modernist universal truth which could be identified through research and uncritically applied generally to any given situation. Clearly, this is not the case, and to make a parallel with Vosniadou's comment (2001) that "people learn best when their individual differences are taken into consideration", I assert that educators teach best when their individual contexts are understood and acted upon. In doing so, I am ascribing an approach of critical pedagogy. In formal education, learning to be a teacher frequently involves understanding one's own assumed norms, and making them explicit in order to understand how to ensure equity for all children in a classroom. However, this is not necessarily the case for informal educators, who may arrive at their role from a number of disciplines, for example, entertainment, science or art (Dowd, 2009). Critical pedagogy is important in socioecological literacy. It means teaching that considers the societal aspects that would advantage certain groups and being aware of this, e.g. power relationships, interests, knowledge production and social inequality (Nichols and Zeidler, 2012). Wolfensberger (2008) explains that the aim of a socioecological approach to environmental education is to allow young people to question their assumptions and values. Before young people can do this, educators need to understand the concept of socioecological approaches thoroughly, and consider how they could be applied in their own context, the extent to which they are suitable for the age group being taught, and the balance between a respect for scientific evidence and a respect for multiple viewpoints.

I would therefore recommend that professional development opportunities for educators, both formal and informal, allow them to consider their personal, normative assumptions about society and the environment, and reflect on how these impact on their current teaching. They would need to consider reflections in the light of current developments in environmental, organisational and educational goals in order to re-draw a 'SPEAK' tree suitable to their organisation. For example, a prioritisation exercise could take place whereby the tree was 'pruned', branches added, and weighted according to participants' views of the relative importance of branches. This would indicate to educators how much time should be spent on different aspects during teaching experiences.

5.6 Concepts of Nature

Children’s perceptions of nature are a topic of enquiry for organisations seeking to reconnect (urban) children with the natural world; see, for example, the report commissioned by the Department for the Environment, Food and Rural Affairs: ‘Engaging People in Biodiversity Issues’ (Christmas et al., 2013). This review was carried out as a baseline to support the Department for the Environment, Food and Rural Affairs’ commitment to engaging more people in biodiversity issues by 2020.
Initially, the literature review for research reported in this thesis involved the fields of museum, zoo and environmental education. The ‘bigger picture’ themes were global and sustainability education, informal science education and formal science teaching. However, through considering the results, it has become clear that place-based education is a field of research which can be drawn upon in order to interpret the results of this work.

Global and local education have become relevant through reviewing the choice of analysis framework for understanding learning. The initial pilot approach used the MLA framework, with domains of Enjoyment, Inspiration and Creativity, Skills, Knowledge, Attitudes and Values, and Activity, Behaviour and Progression. However, Nichols and Zeidler’s 2012 framework ‘Earth Smarts’ instead includes the domains Concepts, Competencies, Values and Sense of Place, as explained in the Chapter 4. If Knowledge, Skills and Attitudes and Values are correlated with Concepts, Competencies and Values, it is clear that the new area to explore is ‘sense of place’. Place-based education (for example, Grunewald and Smith, 2007) is a field that looks at the psychology and philosophy of connection and situatedness in place, and its implications for learning.

5.6.1 Global education and cultural perspectives

According to Nichols and Zeidler (2012), a sense of place involves local and global perspectives. What is the significance of global and local perspectives for children? Why does it matter if children learn about local areas as well as the world, when learning about nature and the environment? Noel Gough (2013) asserts that the phrase ‘Thinking globally, acting locally’ is hackneyed in environmental education, frequently used but rarely reflected on. He considers that a new approach is needed to truly take into account local contexts. The phrase ‘Thinking globally, acting locally’ was coined by Rene Dubos, a Nobel laureate, in 1992. He was a molecular biologist. Some environmental education themes oppose molecular biology perspectives, on issues such as GM crops, for example, and it is possible that Dubos’ arguments may not have convinced researchers in environmental education who were operating from a social science perspective. One of the criticisms of the phrase is that it perpetuates a neo-colonial discourse in environmental education by privileging western interests and perspectives (Gough, 1999). I would argue that this is the case if you consider environmental education that is based in western countries. Annette Gough (2009) explains that the foundations of the International Environmental Education Program (1974) were based on agreements driven by power relationships inherent in international co-operation. She states that ‘Thinking globally, acting locally’ is an “uncontested axiom” (2013:34), citing Greig, Pike and Selby’s work in 1987 *Earthrights: Education as if the planet really mattered* which uses the slogan as a principle that does not need citation to have authority. Callicott and Ames’ (1989) book *Nature in Asian Traditions of thought: Essays in environmental philosophy* compares Chinese, Japanese, Buddhist and Indian worldviews with those that predominate in the west. Noel Gough follows the teachings of Lynn White (1967) who questioned Judeo-Christian attitudes to nature versus others:

> Eastern traditions of thought represent nature and the relationship of people to nature, in ways that cognitively resonate with contemporary ecological and environmental ideals.
>
> (Gough, 279: 19)

I hesitate to dismiss phrases which promote a global view of education, because I feel that overemphasis on semantics can result in abandoning useful ideas. However, Noel Gough makes an important point about cultural worldviews in terms of the relationships between people and nature. What would be truly global education would be to use pedagogies in both formal and informal education that allowed pupils to explore and explain their own cultural views of nature, so that pupils within a class would develop respect and understanding for one another's viewpoints. This debate, which essentially highlights and questions activities which could transmit colonial values, albeit innocently, resonates with themes of 'other' which are well known in museum contexts (e.g. Carbonell, 2012); for a thorough discussion of the topic see MacKenzie (2010).

There is a call for teaching about the natural world, both in museums and in environmental education, which takes into account different cultural views of nature. Zoos have engaged with this through presenting local people's viewpoints about predators (Hoage and Deiss, 1996). Harding raised the issue of Eurocentrism in teaching about nature (1993). Knudtson and Suzuki (1992) raised the issue of losing 'the wisdom of the elders', and this sort of thinking has prompted funding for oral history project co-ordinators in many developing countries, for example in Kenya (Martha Nsiza, community outreach educator, personal communication) and Madagascar (Ony Rabiovola, community co-ordinator, Durrell Wildlife Trust, personal communication). No-one appears to be advocating that it is essential for pupils to learn a set of specific knowledge systems; however, it is important for pupils to learn about several different examples of the ways people interact with natural resources in order to question their own practices. Through attending and presenting work at the 'Science across cultures' conference in 2011 and the World Environment Education Conference in 2012 it is clear that this theme is very much in evidence.

What better way for children to learn about other knowledge systems than by learning from their peers? In today's diverse world, educators need to be aware and skilled in facilitating children in finding out about their traditional knowledge and presenting it to peers. I found that children attended to their peers when choosing objects or areas to look at in the museum and environment centre; evidence was in the form of video observations and children's drawings, where they drew peers saying something or pointing something out (such as in Figure 6.38, showing a 'social signpost'). An implication of these results is that informal educators who work in the field of biodiversity should use pedagogies which allow children time to share their experiences of biodiversity.

5.6.2 Why does it matter if children know about their local area?

The argument for teaching about the local environment is that is resonates with children, it is relevant, and at a level that they may be able to change. I would say that children whose families have lived locally for many years should be encouraged to share their local knowledge as local experts, in the same way that children who have more experience of non-local cultures should be facilitated in taking on the role of more wide-ranging experts. I saw evidence of some children who had excellent knowledge of certain English species, for example a boy who explained Red Kite conservation in great detail. He did not have good traditional literacy skills for his age, and was sitting on a table separately to others because of behaviour issues. However, his ecological literacy was excellent, and it was a great opportunity to boost his self-esteem by recognising this. However, teachers would need guidance in order to recognise this capacity. There is a role for environmental educators, who would be able to identify this sort of ecoliteracy, and communicate it to teachers.

As long ago as 1949, Leopold cautioned that “our educational and economic system is headed away from, rather than toward, an intense consciousness of land” (p223). In recent years, the importance of local place has been acknowledged, for example see Casey (1997) and Gruenewald and Smith (2007). The interrelationships between local culture, identity and place are widely acknowledged within the field of place based education. Casey (1997) makes the point that nothing happens devoid of physical context, yet some concepts are taught as if life took place in a vacuum.

Greenwood (2013) explains the importance of relationships between people and place, proposing a conceptual framework of *place-conscious education*. Greenwood’s concept links cultural and ecological analysis, in particular, emphasising the dynamic status of local surroundings. The framework prompts reflection on the goals of schooling. Greenwood considers that decolonisation and re-inhabitation are the aims of the framework; both educators and pupils need to be able to deconstruct their own assumptions before rebuilding a holistic view of an area (that they could potentially influence), a view that can envisage alternatives. There is a parallel with Barker and Slingsby's (1999) progression framework which suggests that species are the units of understanding ecosystems. Greenwood defines place as "a unique and bounded biophysical and cultural environment" (2013:93); it is of critical importance for pupils who go on to study architecture, ecology, geography, anthropology, philosophy, literary theory, psychology and cultural studies.

What is the significance of this for educators? In order to appreciate the importance of the local context, children need to understand what this is through experience, and then be able to compare it to what other children think is 'normal'. Therefore, educators need to have a thorough knowledge of local species, for example, how many water birds there are, where they can be found, what their life cycles are like and so on, in order to be able to give pupils as rich an introduction as possible into the biodiversity of their local area. Before Greenwood's (2013) proposal of place conscious education, Sobel (2005) proposed place-based education. This is a developmental view of learning which begins with direct, local experience rather than with abstractions.

Greenwood (2013) considers that there are three benefits to framing environmental education research in a place-centred framework:

1. Local focus for socioecological experience and inquiry. Contexts are accessible and relevant to people's everyday lives.
2. Place breaks down the culture/environment dualism.
3. Place encompasses theories of critical geography (Helfenbein and Taylor, 2009) including contested spaces, different uses, voices and stakeholders.

Greenwood (2013) makes a distinction between place-based education as a movement and place conscious education as a philosophical and political orientation to the field. Place-based education can be synonymous with community-based education (Hart, 1992). It is about authentic experience in the local community and environment. Greenwood considers that it usually has the aims of raising student attainment and active participation. It is constrained by the limitations of the school system (Grunewald and Smith, 2007); for example, true agency for pupils may not be possible within the school's organisation processes, and instead tokenism and consequent disengagement is a risk, discussed by Hart (1992) in work on youth participation. In England, the labour government (early 2000s) supported pupil agency in local decisions, and even stated that school governors had a responsibility to ensure that pupils' views were represented in shaping school environments, for example via a School Council. However, unfortunately in England the concept of pupils engaging in democratic processes has fallen out of vogue under a Conservative-Liberal Democrat Coalition government. Figure 5.28 shows Hart's Ladder of Youth Participation (1992), which illustrates degrees of pupil involvement in decision making.

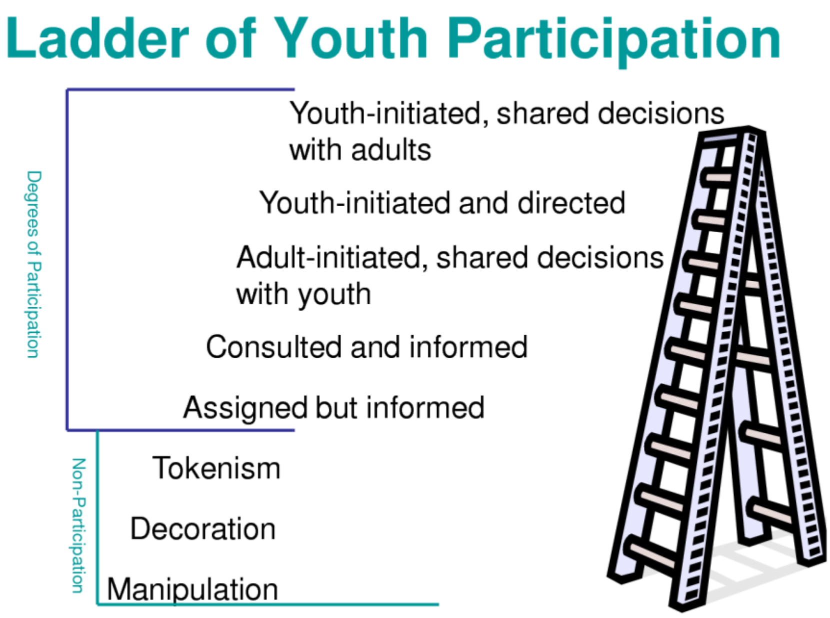


Figure 5.28 Children's Participation: from Tokenism to Citizenship. Adapted from Hart (1992).

Sobel (2005) uses a different approach to promote-place based education, by demonstrating that genuinely locally-based teaching can raise assessment scores, in an attempt to win over formal education opinion leaders. However, Greenwood criticises this approach on the grounds that it reinforces the constraints that prevent pupil voice from having true power within educational institutions. Gruenewald (2005:4) proposes a “Theoretical Direction for Environmental Education: a Critical Pedagogy of Place”. It is sometimes hard to ascertain how the ideas that are conveyed as theory in academic tomes are best translated into action at the level of 8 year olds and what they learn. However, Greenwood (N.B. David Gruenewald changed his surname to Greenwood) has built on earlier work by translating this into teaching points, stating that there are key questions to address:

> Critical questions for place conscious learning:
>
> a) What happened here? (historical)
> b) What is happening here now and in what direction is this place headed? (socioecological)
> c) What should happen here? (Ethical) (remembered, restored, maintained, changed, created)
>
> (Greenwood, 2013:97)

A good example of this approach taking place is Amos and Robertson’s (2012) work at the Field Studies Council Site ‘Viewtube’, an education space at the Olympic park site in London. Working with secondary children, groups discussed the future for the space, allowing disagreements to arise and subsequent agreements to form through the discussion.

There is a benefit to children having a simple understanding of place, a place they have a fondness for, somewhere they can return to for mental wellbeing and relaxation. How this develops their understanding of the economics of place, for example, I am not making claims about. What I can say is that only 76% of the 180 children in this research sample, from King’s Cross in London, were able to name a natural place that they liked. For the children who did not, why? Several possible answers can be proposed:

1. Children have not had the experience of visiting such a place.

2. Predisposition – children have visited natural places, but they actively do not like them.

3. Children have a preference for other things, such as a PlayStation.

What are the implications in later life if children do not have a natural place they know and like? This, and the causes for this observation, would be an area for further research.

5.6.3 Perceptions of natural places

I define 'natural places' for the purposes of this research as outdoor spaces which are, or are intended to have the appearance of being, uncultivated. They are characterised (in most of the UK) by trees and other plants, and there may be evidence of wildlife. They can be different sizes, and are found at various altitudes and on various terrains, and may or may not be located within an urban setting. It is virtually impossible for a natural place to be truly wild in today's UK landscape; however, these spaces are preserved and can be visited by the public to give the impression of being in wild countryside.

The research showed that children's pre-visit responses to the question 'Is there a natural place that you like?' included a range of different countries, some that they had been to on holiday, and some which they were born in or visited with family. Their concepts of 'natural' extended beyond those which would be included by many English adults, for example, outdoor sports grounds.

However, following their visit, the children were more likely to select either the place they had visited or a similar place as a natural place they liked. There appeared to be a cueing effect; for instance, children who had visited Camley Street Natural Park were more likely to select a park as a place they liked after their visit.

Teachers and informal educators need to be aware of the contexts in which children are likely to encounter the outdoors; they may not realise that many children associate 'natural' with sports (notably football and swimming) as well as spaces which appear to have an element of wildness about them. It is also important to remember that many spaces which appear natural are highly managed, for example National Parks in the UK. The relationship between the public and national parks in America was documented by Freeman Tilden (1957); in the United States national parks have long been seen as a key part of national heritage. The definition of 'natural' in England includes meanings such as 'usual', 'innate', 'relaxed', 'pure' and 'real'. There are different meanings and connotations of natural in different languages, countries and cultures. Globally, agreement can be found in the form of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) criteria for recognising outstanding natural places. UNESCO state the importance of recognising cultural landscapes; sites which link society and nature and should be preserved. However, when considering sites which should be preserved, they state six man-made and subsequently four natural criteria for preservation. The natural criteria are as follows:

> (vii) to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance;
> (viii) to be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features;
> (ix) to be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals;
> (x) to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

Reiss et al. (2007) found diverse representations of nature in a study where children were asked to draw a range of natural objects. In a sample which included primary and secondary pupils from independent and state schools, Reiss et al. found a range and variety of conceptions, concluding that teachers need to be more aware of the plurality of viewpoints which children bring to science classes. This conclusion is supported by several studies, for example Reiss (2000) and Osborne and Collins (2000), with the implication that unless diverse views are taken into account, students will lose interest in science at school.

5.6.4 Physiology of learning about place

An important aspect of place-based education is the physiology of visiting a new place, and how learning might be affected by this. Informal learning is affected by the surrounding social, physical and personal contexts (e.g. Falk et al., 2011). This chapter takes a place-based education approach to consider in detail the impact of physical context, choosing this area as it is least discussed in general literature. According to Downs and Stea (2005):

> Unfortunately, the cognitive and mapping ideas have been of only passing concern to psychologists and geographers … We are forced to use an unfamiliar phrase because we do not have a popular expression for this ability that allows us to cope with the problems of understanding the spatial environment in which we live.
>
> (xiii)

In order to imagine this field, we can imagine returning to a familiar space, for example home, where the expected objects occupy their comfortable places and do not threaten the senses with new information. Contrast this with the potential stimulation of exploring a new space where the brain is faced with distinguishing between significant and insignificant detail in order to assign new information usefully. Many people enjoy repeating a familiar nature walk, a resetting of the mind, where the events of the day or week can be reflected upon and disruption from the expected 'wallpaper' of well-known background cues is minimal in order to think about abstract ideas (for example, Darwin's Sandwalk at Downe House). However, I agree with Downs and Stea (2005) that the cognitive implications of new spaces are too important and fascinating to be dismissed. This aspect relates to the Salience Theory of Informal Learning, which will be discussed in Section 5.7.

Why is cognitive mapping important for informal learning about biodiversity? The premise of this research is that three settings which are out of the ordinary for children are being compared, and this Section looks at the implications for learning when it is taking place in a new context, and children are given novel experiences that they have not previously encountered.

5.6.5 How does place affect how children learn?

Downs and Stea (2005:31) suggest that there is a "pervasive human desire to reminisce, to explore, to visit, to fantasize, and to learn about places all over the world … more than the idle curiosity or inquisitiveness". They go on to relate this to the need to know, understand and organise a mental representation of one's environment, which is a survival advantage:

> We must synthesise past and present experiences of our spatial environment with beliefs and expectations about places as yet unvisited or never to be visited. We must accommodate our worlds of fantasy and imagination.
>
> (2005:31)

They refer to organising new information in a new context as a "'mysterious' hidden second nature, which we sometimes refer to in passing but which we do not stop to analyse" (p32). They use the concept of inner space, the representation of the geographical environment within a person's mind, and address the following 'rarely asked' questions:

- How do we know the world?
- What do we mean about the ability to know the world?
- How do we make sense of the world out there?
- How do we learn about new places?
- Does this ability change with age or experience?

This Section will look in more detail at how children learn about habitats when they go on a school trip, how their sense of place is changed through visiting a new place. Understanding cognitive mapping of place draws on research from the social sciences, neuroscience and psychology, where cognitive mapping is an abstraction, covering those mental abilities that enable us to collect, organise, store, recall and manipulate information about the spatial environment. These abilities change with age and learning; how do children recall moving through a new environment?

5.6.6 Direction of attention in new environments

Visual, auditory, olfactory and kinaesthetic information is perceived through sensory receptors. Different people take in information from sensory receptors to different extents. In support of the decision to use children's viewpoint cameras, Downs and Stea (2005:24) note: "To understand the development of cognitive mapping, we must try to see the world through the eyes of a child". They go on to assert that "we know so little about the development of cognitive mapping in children that we are often guilty of two errors: underestimating the child's ability and, on the other hand, confusing it with that of an adult" To give an example of this, from personal observation, children tend to talk about the smell of places much more than adults do. In terms of sensory receptors, your senses are stimulated differently when you are moving through space as opposed to being static, yet how you travel through and to spaces is rarely mentioned as a factor in terms of what children learn. In Chapter 5, the results showed that children's pre-visit associations with natural spaces included verbs in some cases to indicate sports or leisure activities, such as playing in the park and, more frequently than I had expected, swimming. This thesis would be guilty of ignoring relevant evidence through the blinkers of an adult view of what the term 'nature' encompasses if children's views about activity in natural spaces were ignored.

This leads this thesis into the field of *adventure education*, the recognition that activity and how you travel through a new place influences learning and motivation. It must not be forgotten that the key focus of this thesis is biodiversity education; however, in terms of crossing boundaries between disciplines in informal education, the philosophy of adventure education (Wurdinger, 1997) is also relevant to planning a visit to a new space, whatever the curricular topic in focus. Downs and Stea (2005) assert that to know somewhere like the back of your hand means more than knowing a lot about a place; it means grasping the complex of relationships between places, people, activities and routes. In addition to age and experience, our perspectives on the world are coloured by the social group, region and nation that we identify with. As a basic example, an environmental activist may view a desolate piece of land as a potential wildlife sanctuary, whereas a land economist is more likely to view it as an area for development. This transperspectival approach agrees with Lundholm et al. (2013) with regard to environmental education, and Hooper-Greenhill (2013) with reference to multiplicity of viewpoints, despite these authors coming from different fields.

These variations emphasise that our perception of the world depends on our sensory capabilities, age, experience, and attitudes or biases. Therefore, knowledge of space is inextricably linked with identity; fundamentally, personal experience and knowledge are organised according to prior knowledge and personal experience. To return to the idea of categorisation discussed earlier, concepts are not only associated with a 'what' tag, but also a 'where' and a 'when' tag. Perhaps one of the reasons that spatial education has received comparatively little research attention is that forming abstract 'higher' concepts actually involves removing the 'where', 'how' (movement) and 'when' (time, season) tags, to be able to use a concept independently of the concrete conditions in which it was first encountered. However, this is an adult approach, and children are more likely to still have the episodic (when and where) memories of a concept rather than the supposedly context-free semantic (what) memories which emerge after repeated encountering of one concept in multiple contexts which is seen to be best practise for revision. This could be researched further in future by teaching children identical lessons about biodiversity, using the same real resources; however, one lesson would be in a familiar classroom and one in a novel environment. Post-visit activities could explore children's recall of objects and how they were related to the contexts in which they encountered them.

Episodic memory was first described by Tulving (1972), referring to the ability to recall the 'when' and 'where' of past events. Clayton et al. (2007) explain that episodic memory is different from semantic memory because it includes contextual factors. For example, if you know a colleague has submitted a paper at a particular time and whilst working in a particular place, you would recall the content differently than if you had read the content of a paper in a library, written by someone you didn't know. As long ago as 1890, psychologist William James wrote "Memory requires more than the mere dating of a fact in the past. It must be dated in my past" (1890:650). To give an example of this, you may have gone on an 'out and back' walk with someone where you subconsciously return to the same topics you discussed on the way out as you return via the same route and physical memories of place are associated with the discussion you were having at the time. Repeated visits mean that multiple associations are made between one place and meanings, and the more times you visit a place the less important (in this sense) the place becomes. This is known as 'retroactive interference' in neuropsychology; subsequent experience erodes previous connections. This is why repeated learning in the same school classroom can effectively blend into one learning experience, and not be as memorable for children as an isolated visit to a new location. The proposed new research described above would also provide data to address this issue further.

5.6.7 Neural plasticity in new environments

In addition, there is some evidence that neural plasticity (the ability to form new neural connections) is increased in a new space, as an adaptive response to taking in new information and organising it usefully (Bateson and Gluckman, 2011). The supposed survival advantage is to detect threats and link experience, sensory perception and motor action. A benefit of informal learning is therefore that it provides the opportunity for children to search and explore a new space, linking proprioception and sensory information with conceptual information. The implication of this for educators is the need to set expectations; how can they allow children to engage in exploratory activity that will aid the formation of new neural connections?

A key aspect is setting expectations and boundaries. For example, if children are searching for something, what is the search image they are looking for? How will they know if their sensory information has detected a useful object? This was observed in the veterinary college museum; children were undertaking a task with specimens to find, and some asked 'is this it?' once they had found a potential candidate. In order to identify whether it was what they were looking for, they had to use labels to be certain, which for some eight year olds was a challenge. This research therefore recommends that *visual* search images are provided for young children on exploration tasks where they have specific objects to find (which might be specified by organisational objectives; for example, if funding has been given for an activity by a group which address conservation of one species).

Alternatively, open-ended explorations, such as those used in the environment exploration, are more likely to result in uncertainty, and children's curiosity determining the choice of species for discussion. As previously explained, this difference in pedagogy arises from practical considerations; in a museum is it guaranteed that a specimen will be present, whereas an environment exploration can rarely be 100% certain about which animals will be there. Managing expectations is crucial to ensure children do not have a disappointing experience. From a theoretical standpoint, informal education rhetoric supports free choice learning (Falk, 2011). As this quotation from *The Hunting of the Snark* explains:

> He bought a large map representing the sea,
> Without the least vestige of land:
> And the crew were much pleased when they found it to be
> A map they could all understand
> “What’s the good of Mercator’s North Poles and Equators,
> Tropics, Zones and Meridian Lines?”
> So the Bellman would reply and the crew would reply
> “They are merely conventional signs!”
> “Other maps are shapes, with their islands and capes!
> But we’ve got our brave captain to thank”
> (So the crew would protest) “that he’s bought us the best –
> A perfect and absolute blank!”
>
> (Dodgson, 1939:683)

Downs and Stea (2005) also acknowledge that the learner’s ability to control their movement in a space is key, being able to satisfy the urge to look round the corner. This has implications for the relative freedom in rule frame (the degree of control exerted by a teacher or educator) that can be enjoyed in an informal learning setting. One teacher commented in the Royal Veterinary College “I couldn’t let them move round like this, I wouldn’t be comfortable with it”, and a distinctive aspect of informal learning experiences can be the chance for children to direct their own learning in a way that may not be possible in the confines of a classroom.

Selectivity of cognitive mapping

What information is attended to when exploring a new space? The brain would be overloaded if all stimuli were equally weighted; therefore, there have to be some criteria which help decide which stimuli are significant. The educator has a key role in signposting what types of information are stored, how these are symbolised, arranged or ordered, and how relative value or importance is subsequently attached; this will be in Section 6.7. In addition, a 'cognitive map reading process' is needed when retrieving information. Downs and Stea (2005) propose the following factors as criteria for selectivity:

1. Functional importance, e.g. landmarks, traffic lights. They make something happen, or an action depends on them.
2. Distinctiveness or imageability.

(p78)

There are two theories about selection of information. The first is 'Copy theory' where the environmental factors are most important, and a reconstruction in the brain is about the environment. The second is 'Constructivist theory' where the factors in the individual are most important in deciding what information gets stored in a cognitive map. As Downs and Stea put it: "Human cognitive functioning is a constructivist process in which specific environmental criteria are deliberately sought out" (2005:82). I think that these theories interact, and in the next Section I will discuss how they can be considered together.

Key critical features of the environment become incorporated into the person's environmental knowledge. Evidence for this comes from anthropological studies, e.g. wayfinding in natural environments; Tuuaregs, Eskimos, Aboriginies and South Sea islanders have developed similar approaches to wayfinding (Knudtso, and Suzuki, 1992).

Neurophysiology of learning about place

What is the neural basis for making associations between place and other domains (skills, emotion, attitudes and knowledge)? Kaplan's research (1973) demonstrated that places are associated with assemblages of neurons which fire when a part of a place is detected. A frequently quoted example is that of London taxi drivers, who have a larger hippocampus than average. The hippocampus in the brain is thought to be the site co-ordinating spatial knowledge. Essentially, for this research, the most important point to understand is that learning can be thought of as resulting from associations of different neurons firing at the same time, and that repeated co-ordination of different groups leads to learning that results from associations of two or more stimuli.

There is some evidence that new environments lead to increased neural plasticity, that is, an increase in the likelihood that a neuron will give a response to a stimulus. In support of hippocampal plasticity after exposure to new environments, Frank et al. (2000) found that place-specific neurons in the hippocampus showed very rapid changes on the first day of exposure to the novel place; a previously silent neuron quickly became associated with a place and fired when the animal moved through the particular place. This is relevant to informal learning because it means that children's brains could be in a state that is more ready to learn, to form new neural connections, than when they are in the classroom.

5.6.7 Learning and future planning

Past experience is used when planning future actions, with relevance to place. Downs and Stea (2005) explain this with relevance to knowledge about place. Who could argue then, that knowledge about place is not essential to young people being able to envisage and take action towards a more sustainable environment?

This Section has highlighted the fact that adults may not notice the physical contextual (place) factors that children attend to when visiting new spaces.

Educators therefore need to be aware of the factors that are no longer salient to themselves in the physical spaces they work in.

Associating place and concepts is a selective process whereby groups of neurons fire in response to paired associations. The choice of what is attended to in a potentially overwhelming environment is mediated by both sensory factors and brain-driven selectivity, as discussed further in Section 6.7. A knowledge of these physical factors is essential to developing children's understanding of places, which will be needed for understanding how to respond to and shape future environmental changes.

5.7 Salience Theory of Informal Learning

5.7.1 Learning and pedagogy

This research has raised themes which can be synthesised by tentatively proposing a theory of salience in informal learning, i.e. which objects or living things do children attend to, and which are best remembered? This Section will draw together the learning themes found in the previous Sections, and relate them to the learning process and subsequently to pedagogy.

To recap, in environment exploration sessions evidence was seen for the themes of curiosity and discovery, community skills, local awareness, language development, nature as science, environmental problems and ecosystem relationships. Live animal shows demonstrated evidence for the themes of anthropomorphism, ethics, responsibility for nature, prior knowledge, classification/categorisation (taxonomy), animal welfare, change in attitude with relevance to fear, attachment to zoos, and media links. Museum sessions provided data relating to observation, reading, language development, identification, discovery, attachment to museums, and others' responsibility for nature. How do children learn about these themes in informal education?

5.7.2 Learning Process – evidence for categorisation

I found that children learnt species names and classification through informal biodiversity sessions. This is important because these are thought to be the basis for progression in understanding ecosystems (Barker and Slingsby, 1998).

Children learn species names and classification through a process of categorisation, discussed in Section 2.1. Some factors which make up an exemplar are more important than others. Kress and Van Leeuwen (2001), writing about visual culture, consider that 'interest' guides the selection of 'criterial factors' which are the most significant in any given object. For example, the criterial factor of a squirrel is the bushy tail; it is something which is not seen on other animals. Reiss et al. (2007) consider that typical representations of objects seen by young people also guide their choice of criterial factors, for example, images frequently seen in the media; therefore, choice of salient factors is also influenced by culture.

Keil (1979) found that 5 year olds categorised animals by appearance whereas 11 year olds did so by name. Qualitative evidence showed that the children studied in this thesis did notice potentially discriminatory features, as demonstrated by the child's description of physical qualities in Figure 5.29.

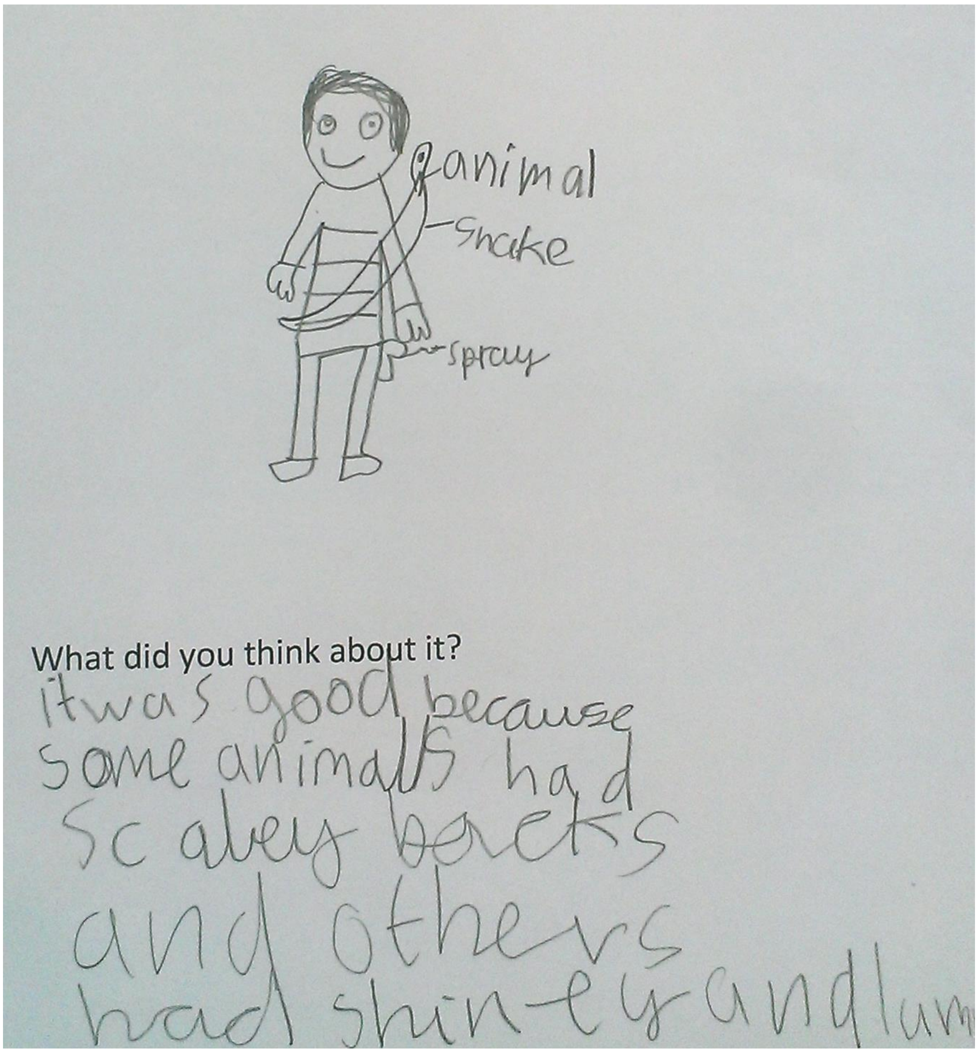


Figure 5.29 A child's description of animals' surface textures.

The more variety children see in animal forms, the more opportunities they have to refine their categories and try out new examples against the exemplar:

> As children come into contact with more animals, they will learn basic names and begin to recognise the principle attributes (exemplars) of the categories (common or zoological) into which the organism belongs.
>
> (Patrick and Tunnicliffe, 2013:76)

A confounding issue is that tags (names) and physical representations of concepts do not have a one-to-one relationship. For example, a pet cat has a personal name, a common name and the scientific name *Felis domesticus.* It is in the category ‘carnivore’, and, when it is a kitten, it will look different to its adult form. Therefore, metamorphosis and life stage appearances can affect children’s perception of exemplars, and class inclusion. These factors often lead to inaccuracies in comprehension (e.g. Trowbridge and Mintzes, 1988).

Some informal educators consider that assigning a name or tag to a physical specimen closes down conversation and restricts curiosity. However, I would assert that educators need to develop skill in enhancing a child’s conversation, but at the same time leaving the child with a name (i.e. a communication tool) to convey to others what they have seen or handled. Markman (1989) notes that “children intuitively want to know the name of things they see because the name is the code for a concept and it allows it to be discussed” (p17).

Therefore, experience of handling objects, seeing living animals in an environment centre or in a live animal show are all experiences through which children can refine exemplars and learn new tags with which to communicate. The following section will consider which aspects of an informal visit are memorable and why.

5.7.3 What is memorable and transformative in informal education?

This section summarises considerations about what children learn in informal biodiversity settings by proposing a Salience Theory of Informal Learning, showing how attention is captured by physical characteristics of environmental stimuli, and attention is focused through higher order signposts which filter information.

In this theory, I suggest that there are two pathways through which children’s lens on a new experience is affected: one concerned with cognitive factors (which could be seen as ‘top-down’, starting with complex information and affecting processing of simple stimuli) and one concerned with sensory factors (which could be described as ‘bottom-up’, starting with simple stimuli leading to a complex response). As shown in Figure 5.30, cognitive attention factors include Emotion, Social signposting, Prior experience and Imagination. Sensory attention factors include Sight, Touch, Sound, Smell and Taste.

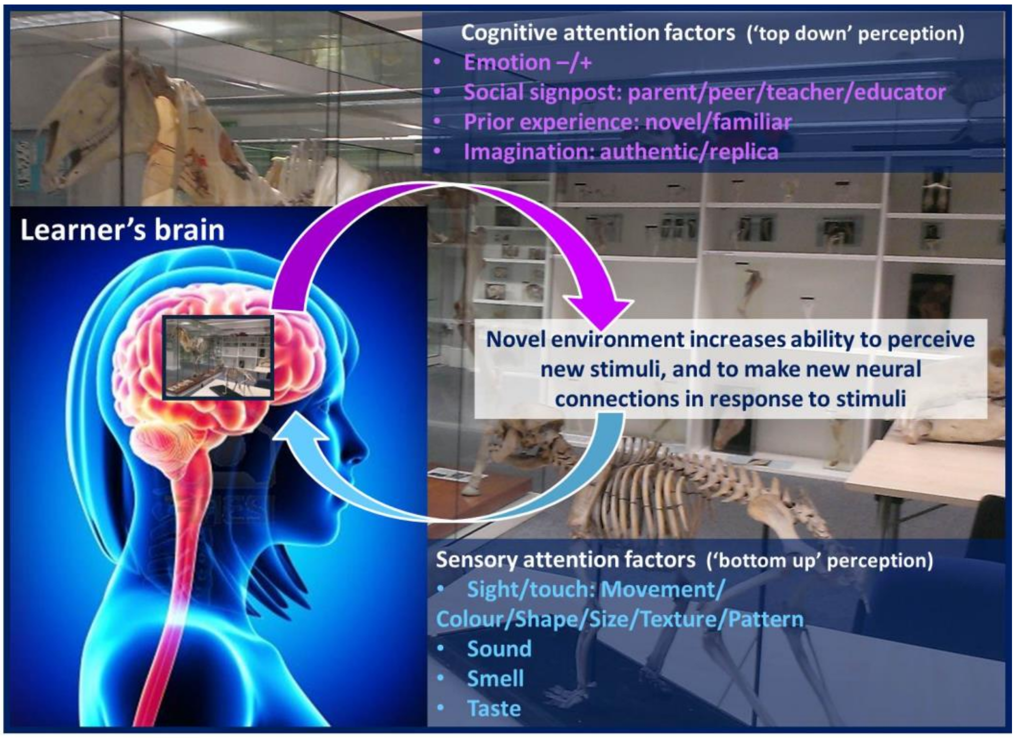


Figure 5.30 The Salience Theory of Informal Learning

This section will draw on literature from museum, zoo and environmental education (informed by the literature review presented in Chapter 2). It will incorporate reading in the fields of place-based education, adventure education and neuropsychology to devise a new way of thinking about the results. The theory presented here is intended as a basis for discussion, and further research would clearly be needed to ratify the ideas which are being proposed. It is also intended as a useful architecture for educators to understand the process of learning and use aspects of this for planning learning activities in informal spaces.

5.7.4 Definition of Salience

Salience is from 'saltere', the Latin for 'to jump out'. Synonyms are 'strikingness', 'prominence', 'conspicuousness' and 'visibility'. The meaning 'pointing outward' (preserved in military usage) is from 1687. In heraldry, a salient animal is one which is leaping, for example a lion salient. In physical geography a salient landform projects out from its surroundings. In psychology, the idea of an 'attentional spotlight' to focus on important stimuli is often used as a communicative description, or to highlight an aspect of an experience or set of stimuli.

In cognitive neuroscience, the saliency of a stimulus (e.g. an animal specimen or a living thing detected by the senses) refers to the extent which it is noticeable compared to its surroundings. Psychology research often looks at the contrast between a stimulus and background. So, for visual stimuli a black line would stand out against a grey amorphous background, for sound a loud noise would be clearly heard above low level white noise, and so on. Research in this field has included studying salient stimuli for computing and games (Cain and Mitroff, 2011), in order to understand which on screen items would be noticeable to players. In addition, there are a number of instances of military research about salience in the field of research known as 'situation awareness' (Kass et al., 2007).

In this section, I apply ideas from these fields to authentic, on-site informal learning experiences. Understanding the sensory basis of salience is the basis for the idea that sensory factors are important in understanding *memorable* aspects of informal learning when pupils visit a new place.

Salience detection refers to how the process of attention focuses the necessary processes on a limited range of stimuli so as to cope with a potentially overwhelming number of environmental stimuli. In order to direct attention, resources of energy, perceptual and processing power are required. Prioritisation cues affect which stimuli are attended to, and these are discussed below with reference to cognitive factors in informal learning. The two-way relationship between cognitive factors and stimuli is important in understanding *transformative learning* (Meizrow, 1997; learning which has a long-term and important effect on the learner's architecture of understanding, including their identity). The theory of transformative learning has been developed in formal adult education to take into account the extensive prior experience that adults bring to new learning sessions. However, transformative learning is increasingly applied to young people's learning, acknowledging the extent of children's prior experience (e.g. Vante Bintliff, 2012).

Taylor and Fiske (1978) historically proposed selective attention and discussed how it is influenced by intrinsic features of stimuli as well as the perceiver's dispositions and physiological needs. They found that salient features are preferentially recalled, and caution against the 'unsurprising, uninvolving, and unarousing' as situations where typical controlled attentional searching behaviour will not be elicited. More recently, Rumbaugh et al. (2007) discuss a salience theory of learning and behaviour where they counter a behaviourist view that simply links stimulus and response. Instead, they eloquently articulate the organisation of neural responses and consequences for subsequent cognitive aspects of salience. Their paper is significant because it counters claims that salience theories are oversimplistic and behaviourist.

5.7.5 Cognitive attention factors

Top-down perception factors could also be called cognitive factors, those which originate in the cortex and highlight information, make it jump out, for factors other than sensory qualities of a given stimulus.

Emotion –/+

The inclusion of emotion as a domain in the SPEAK framework (Chapter 5) was necessary in order to represent observed behaviour. I included it when revising the Earth Smarts framework (Nichols and Zeidler, 2012) as a basis for understanding the learning that had taken place in the museum, environment centre and at live animal shows. I justified that it was important to have this extra domain because the emotions observed were both positive and negative, and did not just refer to affective connections with place (which is included in Nichols and Zeidler's domain definition for sense of place). I suggested motivation, disgust and fear as subcategories of emotion. This clearly has the potential for future research to describe the range of emotional responses in finer detail.

However, here I am using the domain emotion to argue that emotional responses coupled with a physical stimulus make the experience more memorable. There were three emotional aspects which were particularly noticeable in the three settings investigated: fear, humour and excitement. Whether an event is attractive or aversive is mediated by the dopaminergic pathways in the brain; the neurotransmitter dopamine is involved in associating a stimulus as positive or negative.

Fear

Figure 5.31 shows a drawing which conveys the emotion of fear.

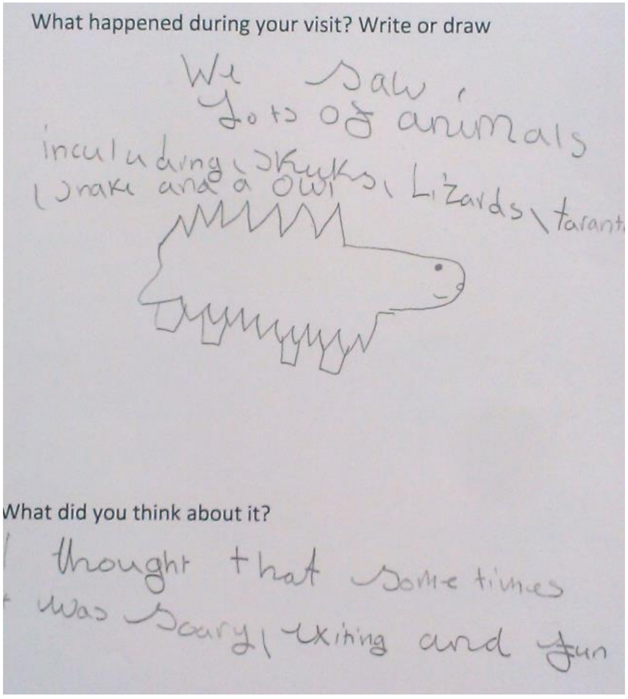


Figure 5.31 Child’s drawing showing recall of meeting live animals.

This child’s work in Figure 5.31 shows that they recalled the thrilling nature of meeting live animals; they were feeling both frightened and excited at the same time.

Excitement

Many of the children were clearly excited by the chance to visit a new place, as indicated by exclamations and expressions of delight and enjoyment. For example, Figure 5.32 from a pupil's headset camera at a live animal show is accompanied by her exclaiming 'Wow!' in a quiet whisper (so as not to scare the Chinchilla).

Figure 5.32 Excitement at seeing a live animal

Humour

Figure 5.33 shows a child's recall including the sentence 'I liked it because he was telling jokes'.

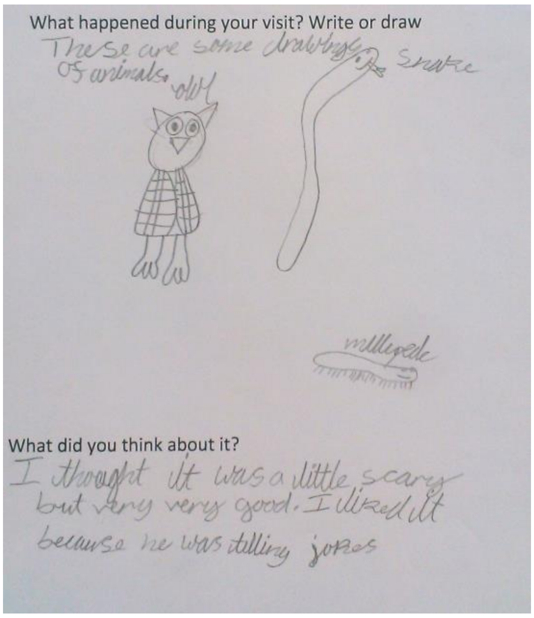


Figure 5.33 A child's drawing – evidence of recall of humour.

In Figure 5.33 a child who has seen a live animal show comments that they enjoyed the experience because the presenter was telling jokes. Whilst the psychology of humour is not often included in academic consideration of learning, it is nonetheless important for pupils, and educators could reflect on their use of humour as appropriate to audience. For example, Figure 5.34 shows a class teacher reflecting on Live Animal educator Stuart's use of humour and pace.

Figure 5.34 Humour and energy in memorable learning

5.7.5.1 Social signpost

Peer

As in Vygotsky's theories of social learning, children were clearly heard to explain and signpost new information to one another. This is consistent with results observed in the pilot study, and the results at that stage were correlated with Doris Ash's work on thematic continuities in children (2007). That is, they try out new concepts by assigning newly learnt 'tags' associated with a concept in novel situations and modify their concepts based on the response. Figure 5.35 below shows a child's drawing recalling a visit to the museum.

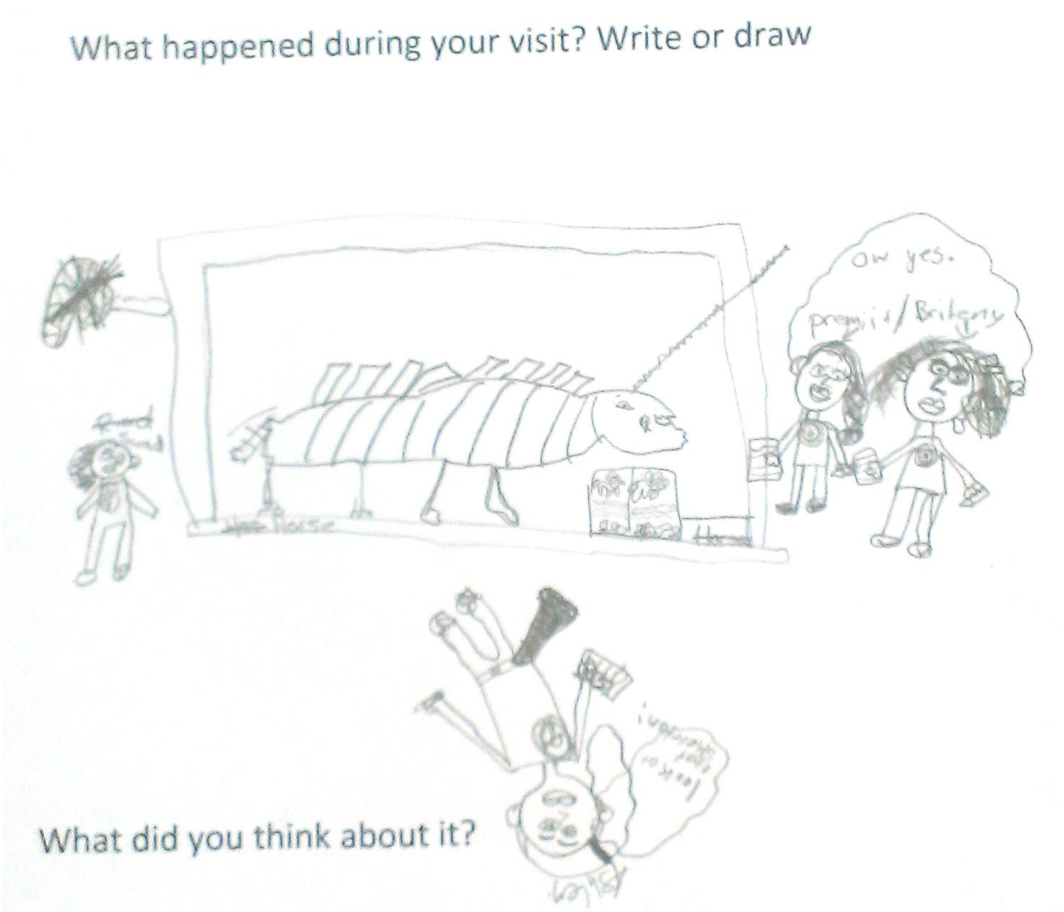


Figure 5.35 A child's drawing of a visit to the museum showing 'social signposts'

In Figure 5.35, children are talking with each other and signposting a specimen of a horse to one another: 'Look!'.

Parents and accompanying adults

Figure 5.36 shows a child's drawing recalling a visit to the museum including accompanying adults.

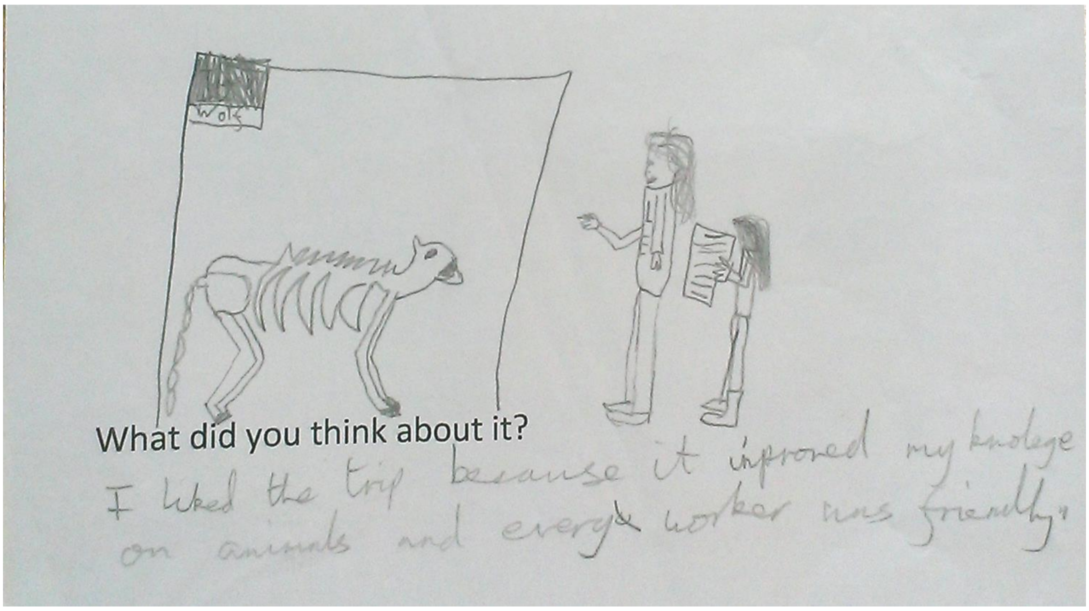


Figure 5.36 Child's drawing of a museum visit showing accompanying adults

The role of accompanying adults in facilitating visits was salient for some children, for example the girl who drew Figure 5.39 wrote 'every worker was friendly'! Whilst there are other aspects of her view of workers which may be interesting to reflect upon, the fact that accompanying adults are important for children is significant for educators, because frequently activities for accompanying adults are not included in session planning, often with the justification that because you cannot rely on the presence of adults there is not a need to plan for them.

Teachers

Figure 5.40 shows a child's drawing recalling a live animal show, specifically when the teacher held a tarantula.

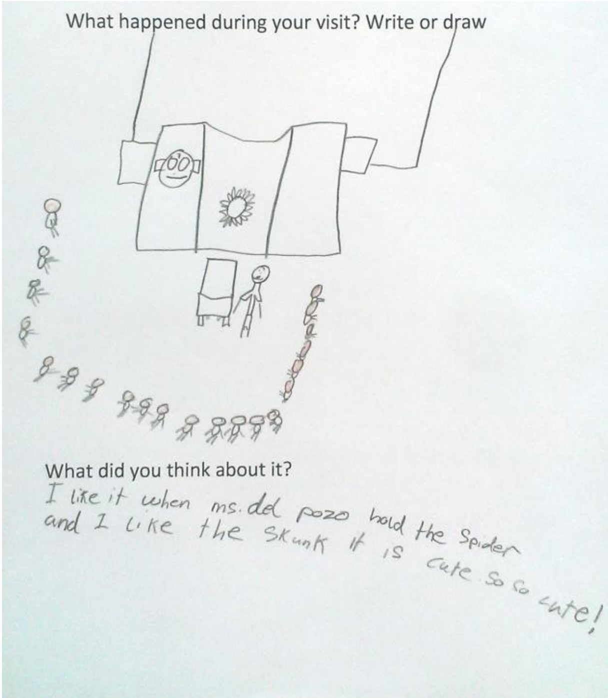


Figure 5.37 Child's drawing recalling a live animal show, showing recall of teacher involvement

Children have close relationships with their class teachers, and they are often very attentive, watching what their teacher, as their leader, does in a new situation. Figure 5.37 provides supporting evidence for this. Therefore, educators should plan to include class teachers in ways which focus children's attention on aspects of their experience. Working together for pre-visit planning can ensure that the educator and class teacher support each other in maximising the benefit of a trip. Practical examples of including teachers can be seen on both the Variety Show and Animal Vision (Key stage 2/3 classification and adaptation shows at the Natural History Museum's Darwin Centre). In the Variety Show, designed by NHM programme developer Sally Collins, the teacher takes on the role of someone who has found a mystery specimen, and children have to ask the teacher questions about a specimen that only the teacher can see. Involving teachers in this way has the potential to make experiences memorable for pupils. Figure 5.38 shows a teacher handling a live tarantula.

Figure 5.38 Video still of one of the live animal shows showing a teacher with a tarantula

Educator

The educator has an important role in facilitating children's ability to discern what is significant in a new space and, correspondingly, to appreciate which details do not need attended to. How this is achieved, through informal learning pedagogy, is covered in the literature (e.g. Hooper-Greenhill, 2013); however, the issue is raised here to emphasise the educator's role as a signpost, to point out highlights to children so that they can explore them. For example, Kellert (1985) found that zoo educators enhance children's interest by focussing on the affective domain and emphasising emotional concern and sympathy for animals.

This perspective should influence educators in their choice of pre-visit material, the information which children can be shown to accustom them to consistent features of a new space, and therefore understand which are significant by seeing a search image associated with a narrative, for instance. For example, the Science Museum sends a pre-visit PowerPoint to schools which shows the journey to the Science

Museum, and introduces them to the appearance of some typical spaces. Much writing about museum education in the 1950s and '60s (for example, Palmer's work about the NHM (1954) and Marcouse's work about the Victoria and Albert Museum 'The Listening Eye', 1961) contains material about the need to prime children by showing them the overall space, before they can attend to finer detail.

In addition, children attend to different aspects of an experience according to when it takes place in the sequence of activities. In psychology this is known as primacy and recency. Things which happen first are remembered well (primacy), and final events are salient too (recency). Around 70% of the way through a visit is when recall is least likely (Morrison et al., 2014).

Personal identity

If children take part in an activity, or use resources associated with a particular role, learning can impact on their sense of identity. The drawing in Figure 5.39 shows a child's picture of themselves using binoculars, and there is considerable literature about museums and identity (Falk et al. 2008). The more opportunities children have to see themselves as people who go to museums, or who take part in specific cultural activities such as nature exploration, the more likely they are to see these activities as worthwhile opportunities in future. This is an example of making learning transformational – it alters children's perception of themselves and the activities they enjoy and are competent at. It develops their confidence to enter similar situations.

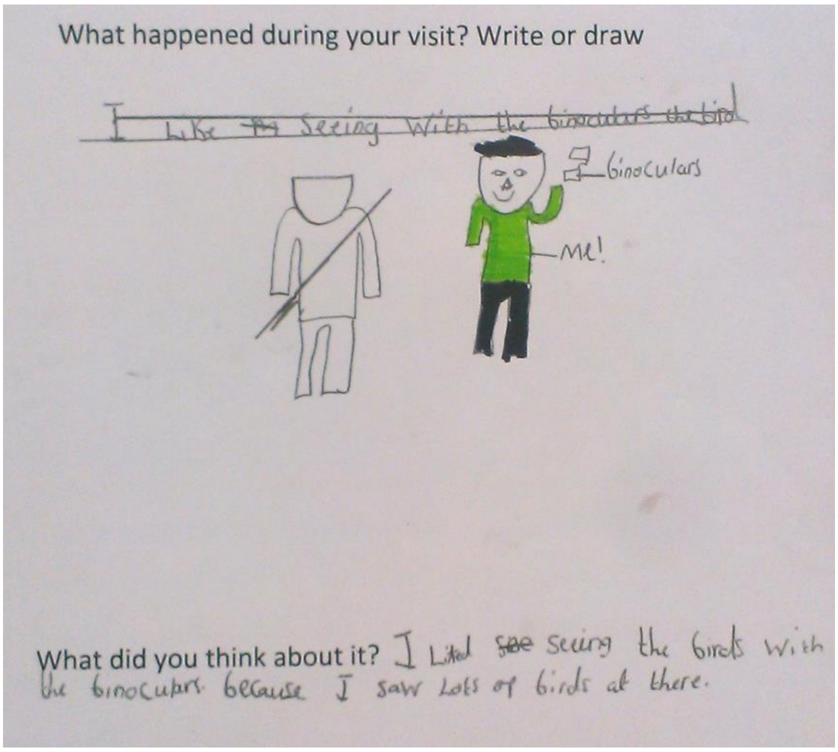
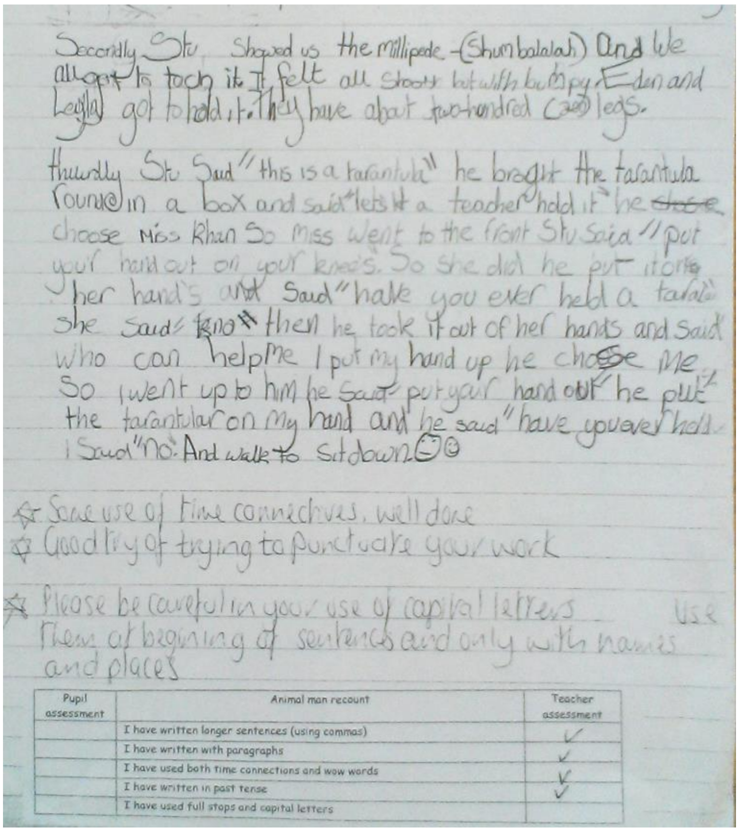


Figure 5.39 A child’s drawing showing identity in an environment exploration. Supplementary evidence.

In addition to providing activities which allow pupils to see themselves as engaged in biodiversity issues (for example, by carrying out a survey of different species, being environmental scientists, carrying out small-scale habitat conservation activities etc.), another way to involve children is by offering them opportunities to develop confidence in authentic situations. So, for example, the child who wrote the text in Figure 5.40 was chosen to handle one of the animals.



Secondly Stu Showed us the millipede (Shumbalalah) And We all got to toch it It felt all Smooth but with bumpy Eden and Leyla got to hold it. They have about two-hundred (200) legs.

thurdly Stu Said "this is a tarantula" he bragit the tarantula round in a box and said "lets let a teacher hold it" he ~~chose~~ choose Miss Khan So Miss went to the front Stu Said "put your hand out on your knee's. So she did he put it on her hand's and Said "have you ever held a tarant" she Said "no" then he took it out of her hands and Said who can help me I put my hand up he choose me. So I went up to him he Said put your hand out" he put the tarantular on my hand and he said "have you ever held I Said "no" And walk to Sit down

Some use of time connectives, well done

Good try of trying to punctuate your work

Please be careful in your use of capital letters Use them at beginning of sentences and only with names and places

Pupil assessment	Animal man recount	Teacher assessment
	I have written longer sentences (using commas)	✓
	I have written with paragraphs	✓
	I have used both time connections and wow words	✓
	I have written in past tense	✓
	I have used full stops and capital letters	

Figure 5.40 Child’s writing recounting handling an animal. Supplementary evidence.

Other children will remember that writer of the text in Figure 5.40 was chosen for this task, and it will become part of the information which other children associate with her. Choosing individuals in shows where only a few volunteers take part in a given experience is always contentious; however, given the need to safeguard animal welfare it is often not advisable for more than two or three children to handle a given animal. Identity is an extensive field in museum education; for example see Falk (2009).

5.7.5.2 Prior experience

Novelty

The writing in Figure 5.43 also illustrates the importance of novelty; the child writes that she had never held a tarantula before. This is particularly memorable, and here the educator makes this link explicit for the child through questioning. Neural plasticity in novel environments has previously been discussed, and is included here to reiterate that it is a feature in promoting salience. Figure 5.41 shows the importance of seeing novel things; a child has recalled the new experiences.

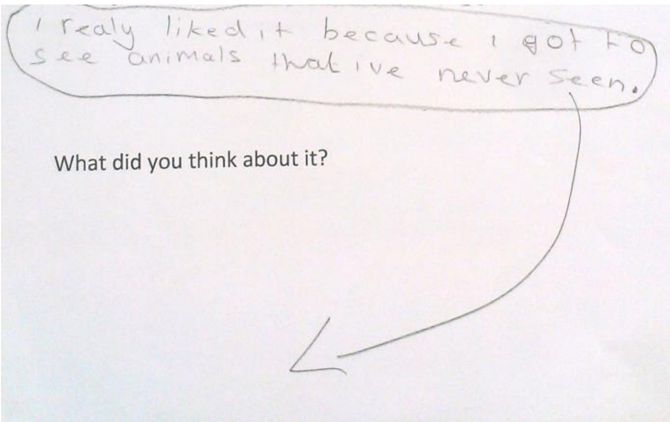


Figure 5.41 A child recalling seeing new animals

Conversely, when animals are well known, they are less likely to be memorable and may evoke the sort of response seen in Figure 5.42, a still from a post-visit interview.

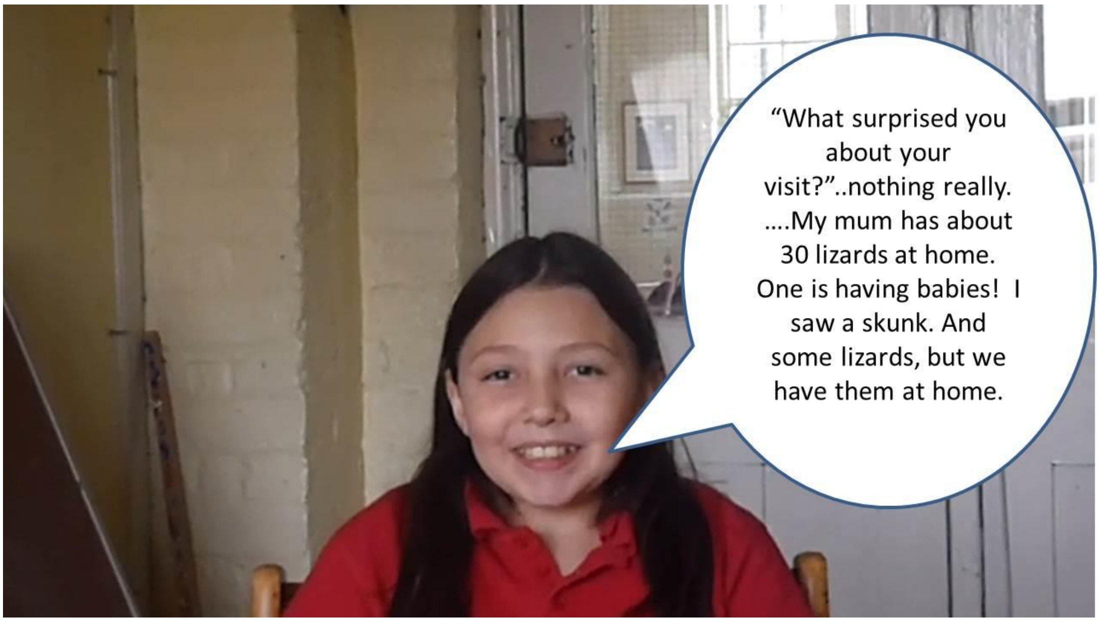


Figure 5.42 A girl recalling meeting live animals

Familiar

The familiar, being able to link to prior knowledge, allows children to situate their new learning in an existing emerging architecture, and to have frames of reference within which to consider new information. McManus (1989) found that some people focus on aspects of animals which are familiar. The drawing in Figure 5.43 shows how a child has recalled familiar concepts when she writes about making bird cake.

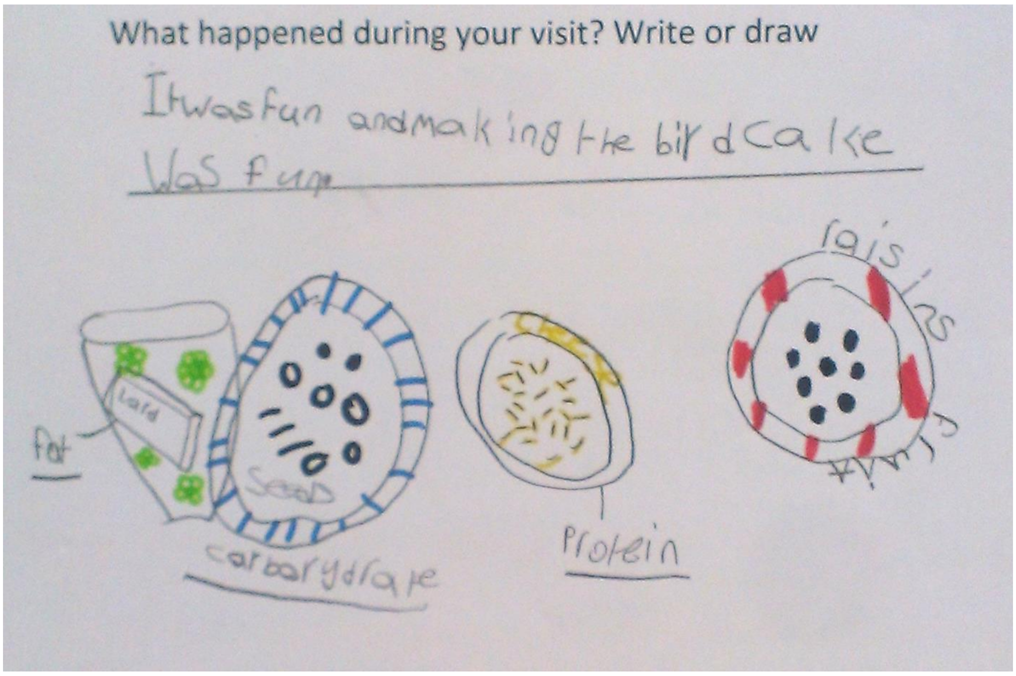


Figure 5.43 A child's drawing recalling an environmental exploration activity. Supplementary evidence.

In Figure 5.43, the child has associated the activity of making bird cakes with existing knowledge about nutrition, and added these as labels. Therefore, when she next thinks about the food groups, she is likely to also be able to recall information about making a bird cake at the environment centre. It is well known in informal learning pedagogy that linking to prior knowledge is important, and this can often be observed in the initial questioning stage of a session plan; children are asked what they know already, and if they have visited similar places.

5.7.5.3 Imagination

Imagination is envisaged for this thesis as creative thinking that uses informal learning experiences as a starting point. The importance of imagination in learning about biodiversity was raised in Section 2. Comparing reality with expectations requires the use of imagination at first, followed by reflection on the mismatch between projected experience and actual experience, which may result in surprise. This is raised here because it relates to the importance of authenticity for children. As suggested in the pilot study, they frequently comment on the 'realness' of artefacts or experiences. As shown in Figure 5.44, the child has written 'it was disgusting because the bones were real' (paraphrase). I argue that the significance of authenticity is at least partly in the power to elicit imagination, the idea that something else has happened to the physical object or living thing, which only the imagination can envisage (see for example Knell et al., 2014 for discussion). So, for example, real bones have actually been attached to muscles and connective tissues and moved around as part of living things. Holding this vision is quite an arresting thought! Likewise, imagining life and journeys that living things have encountered brings a different view of nature that can be powerful, particularly for those young children who are free enough from mental distractions to engage in entertaining pasts and futures for given objects. I think this is partly because such children are immersed in the culture of visual narrative as they are learning to read, and can often readily compose stories about animal characters as a consequence. Figure 5.44 shows a child's drawing recalling a visit to the museum, where they saw and handled real bones.

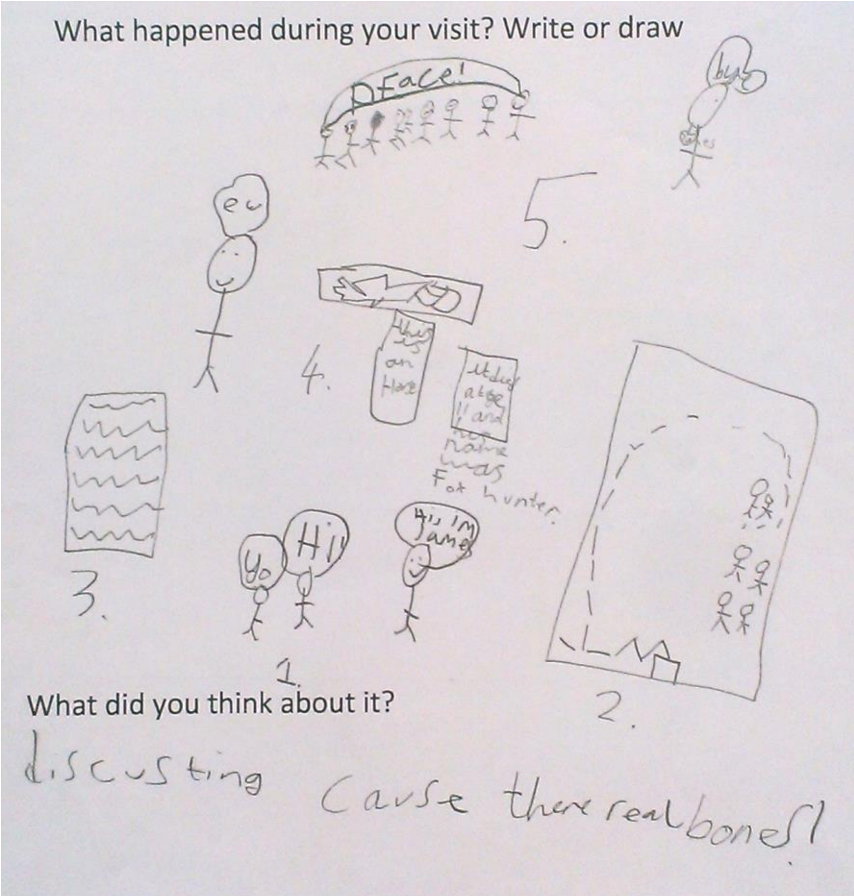


Figure 5.44 A child’s drawing of a visit to the museum, showing recall of authenticity

When real artefacts are not available, replica artefacts still allow children to use their sense of touch, and therefore are better than not using physical conceptual supporting material. Likewise, Patrick and Tunnicliffe (2013) note the use of recorded sounds in zoos, which still elicit the senses despite a lack of authenticity. Hills (1995) found that zoo visitors are motivated to look closely by interest, empathy, idealism and belief in the apparent natural state of animals. Children are very perceptive about the authenticity of discovering something real, and the subject of salience due to authenticity in nature could be a focus for future research. The concept of authenticity has received considerable treatment within the museum studies literature, and a number of antonyms exist for the term depending on the specific context. For example, ‘real’ or ‘authentic’ can mean alive, three-dimensional, true, genuine, original …; therefore, antonyms are dead, two-dimensional, fake, replica ... Of growing interest is the antonym ‘virtual’, and the museum literature stresses the benefits of museums holding material collections, now that access to knowledge is increasingly ubiquitous through the internet (see, for example, Trant, 1999; Dudley, 2013). The importance of authenticity and imagination for informal learning experiences about biodiversity in museums, environment centres or zoos is an area which has been identified for future investigation by this research.

5.7.6 Sense-driven attention factors

According to my own cultural context, I initially looked at the five well-known senses: sight, sound, smell, touch and taste. However, there are, of course, a range of internal regulators which sense aspects such as temperature, pain, breathing rate, blood glucose and heart rate. For the purposes of this theory, the common senses will be focussed upon. Laird (1985) found evidence that 75% of adult learning is by sight, 13% was hearing, and 12% touch, smell and taste. This, of course, tells us about both individuals and their environments. Typically, there are fewer opportunities to learn through the latter senses than the former, though this might not have been the case before the advent of artificial lighting and is manifestly not the case for blind people.

Figure 5.45 shows Live Animal educator Stuart explaining the importance of the senses when encountering live animals.

Figure 5.45 Post-visit interview: senses and live animals

Sight/touch

Neural processing of visual stimuli depends on pattern recognition, comparing new information to existing concepts, maps and understanding and evaluating data, making a judgement. The information may be assimilated, and the overall construct changed, or it may be rejected and the initial construct will remain, resilient to new information. The sort of factors that might make this happen are if the new information comes from a source which the viewer judges to be unreliable, or too different from their initial conception to accommodate.

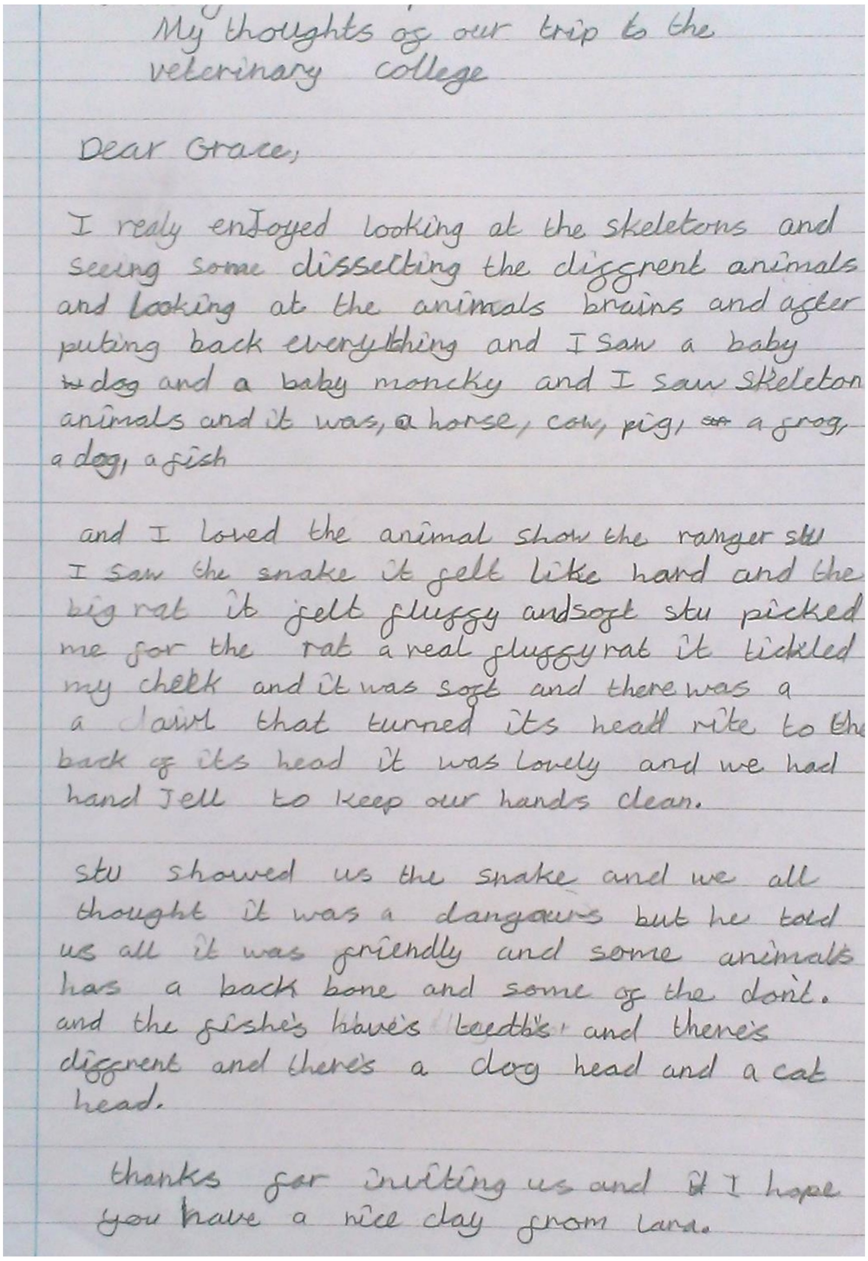
Visual perception of the world depends on pattern recognition, and familiar sights are not attended to; mental energy is not wasted on decoding them, to allow efficient movement through the world without attending to every detail. How is the attentional spotlight attracted by physical properties of new situations?

Sight

Visual receptors (rods and cones) in the retina of the eye attend to stimuli that have the following characteristics: salient movement, colour (hue or intensity), shape, size, texture or pattern. For salient, one could read unusual, i.e., as explained at the start of this Section, they stand out from the background in some way. So, a bird that was moving much faster than others would be salient because it was different from normal. Stimuli that have properties which are different to the background information are likely to be noticed independently of cognitive attention focussing. Evidence for children recalling salient visual stimuli in this research was shown in their descriptions of animal appearance and behaviour. Conversely, salience can also stand mean 'very well known'; familiar people are salient for example.

Touch

Figure 5.46 shows writing recalling the sensation of touching the animals.



My thoughts of our trip to the veterinary college

Dear Grace,

I realy enJoyed looking at the skeletons and seeing some dissecting the diffrent animals and looking at the animals brains and after puting back everything and I saw a baby ~~bo~~ dog and a baby moncky and I saw skeleton animals and it was, a horse, cow, pig, ~~or~~ a frog, a dog, a fish

and I loved the animal show the ranger stu I saw the snake it felt like hard and the big rat it felt fluffy andsoft stu picked me for the rat a real fluffy rat it tickled my cheek and it was soft and there was a a owl that turned its head rite to the back of its head it was Lovely and we had hand Jell to keep our hands clean.

stu showed us the snake and we all thought it was a dangours but he told us all it was friendly and some animals has a back bone and some of the don't. and the fishe's have's teeth's and there's diffrent and there's a dog head and a cat head.

thanks for inviting us and ~~I~~ I hope you have a nice day from Lara.

Figure 5.46 A child's letter recalling meeting live animals and visiting the museum.

The sense of touch is how we learn about objects through discovering properties such as hardness, softness and texture; for example see the child's description of the Chinchilla, described as a big rat. The sense of touch is complex as it is related to pain, temperature or pressure. It is mediated through skin sensors. It is also linked to emotion, e.g. slimy is equated with disgust, soft sand is equated with delight, and we manifest shock at extremes of temperatures. In Figure 5.43, one boy recalled making a bird cake, with specific recall of the different foods required. This activity involves sensation of food texture through touch and mixing. In addition, use of objects, e.g. building blocks, binoculars and thermometers, also involves a sensation of touch, of what the object feels like and how hot it is. Figure 5.47 shows Museum educator James explaining that pupils are allowed to handle specimens.

Figure 5.47 Post-visit interview: handling specimens in museums

The importance of touch when considering objects is of interest to museum educators. At the Royal Veterinary College it is easy to handle objects since are they are an educational collection; however, this is not the case in all museums. For example, the purpose of a taxonomic collection includes preserving type specimens rather than allow unrestricted handling. Some educators advocate that museums provide far more opportunities to allow visitors to handle items, in ways which will not cause damage to the objects. See Paris and Hapgood (2002) and Candlin and Guins (2008) for reviews.

Sound

Figure 5.48 shows a child's drawing recalling meeting live animals.

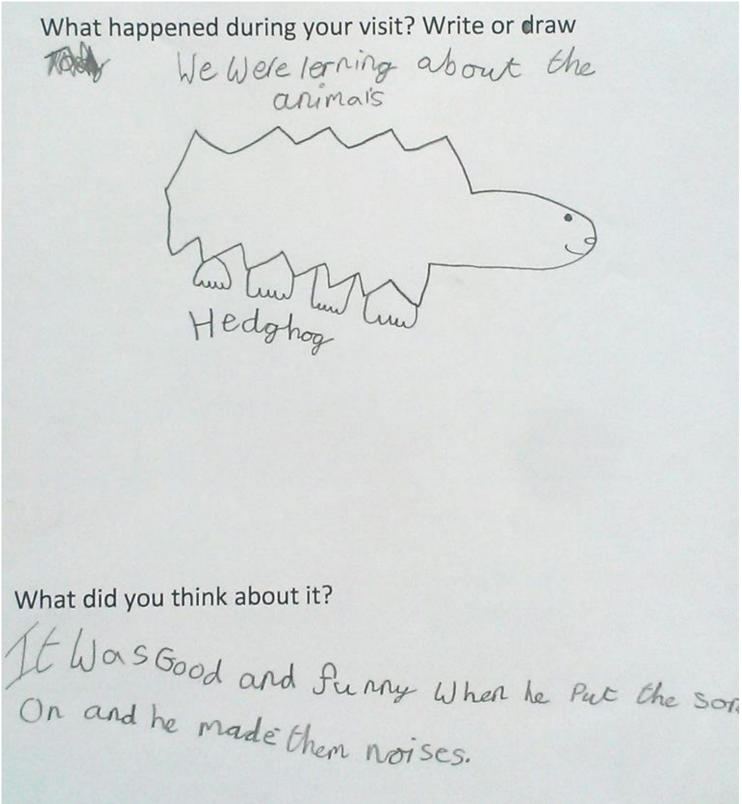


Figure 5.48 A child's drawing recalling meeting live animals, showing recall of sound.

Children recall unusual noises clearly, as shown by the comment 'he made them noises' in Figure 5.48. Their imaginative comments frequently include anthropomorphism, such as imagining what an animal is saying. Noisy animals trigger interest and visitors stay at an exhibit longer (Bitgood and Patterson, 1987).

Hearing is clearly important for the sound of an animal and for spoken communication. However, background noises also have to be considered. For example, at Camley Street Natural Park, near Kings Cross visitors can hear the sound of trains, traffic and the city. In contrast, another natural park may be much quieter. In this way, such a park would have a property similar to lateral inhibition, increasing surprise because you don't expect it to be there. There is almost disbelief that it can be possible that this oasis of calm exists right in the heart of the city.

Smell

Children commented on the smell in the Royal Veterinary College, where one aspect of their visit included going near a dissection room. They also commented on the compost bin smell in the environment centre, and the thought that the Skunk could potentially release powerful gases was highly salient for some children, who recalled that bathing in Ketchup was one way to escape the smell. Culturally, adults seem to comment on smell less than children. One use of smell in biodiversity education would be to ask children to understand the relevance of smells from different species' points of view, in order to start to comprehend the different physiology of a variety of species. This is mentioned here because the smell of an animal is an aspect which children do remember and, whether negative or positive, it will affect their recall of a new experience, so should be considered.

Taste

None of the sessions here involved using the sense of taste, although I have seen biodiversity education sessions which use food tasting when dealing with edible foods, for example. Educators should be aware that use of additional stimuli such as taste could increase children's ability to recall a session.

5.7.7 Models integrating both sensory and cognitive factors

It must be noted that the approach of integrating sensory and cognitive factors implies a splitting of body and mind, and so could be said to be a product of current Western culture, almost mind-body dualism. Culture affects sensory perception, both in terms of the stimuli available and the cognitive signals to attend to it. Social cues indicate to children which aspects of their environment are valuable. Mezirow (1991:1) states that "approved ways of seeing and understanding, shaped by our language, culture and personal experience, collaborate to set limits to our future learning". However, an approach linking cognitive (including cultural) and sensory factors in learning is not new, although applying salience factors to informal learning situations has not been done specifically in this way before, as far as the author is aware. Key pedagogues have linked physical and cognitive factors; for example, Aristotle founded a Lyceum based on the principles of exploring and gathering evidence both physically and through discussion (whereas Plato and Socrates were advocates of discussion only as the main mode of developing concepts). Dewey (Hein, 2012) defined an experience as a transaction between an individual and their environment. The environment was defined as whatever conditions interact with personal needs, desires, purposes and capacities to create the experience. Piaget (1962) noted that young children learn through physical exploration and the observation of cause and effect.

In 1954, Dale suggested that zoo or museum visitors are more likely to comment about exhibits that are memorable, because they are unusual in design, elicit the senses or are personally relevant. Gregory's significant work in *Eye and Brain* (1997; first published 1966) used the neuroscience of the day to suggest that there was more to the senses than what meets the eye. Eisner (1991) highlighted the role of previous experience. Bohm (1994) and Krishnamurti (1994) see 'antecedent knowledge' as a problem to be overcome in seeing 'truthfully'; however, many social scientists would not view this as a problem but as a culturally etched lens and would contest their assumption that there is ever a universal or objective viewpoint.

Experiential Learning

Experiential Learning is a movement that refers to learning from embodied experience, fundamental to human (and animal) learning. It is clear from the results of this research that it is a key theory for this research. Kolb (1939) was the founder of the Experiential Learning Cycle, as shown in Figure 5.49.

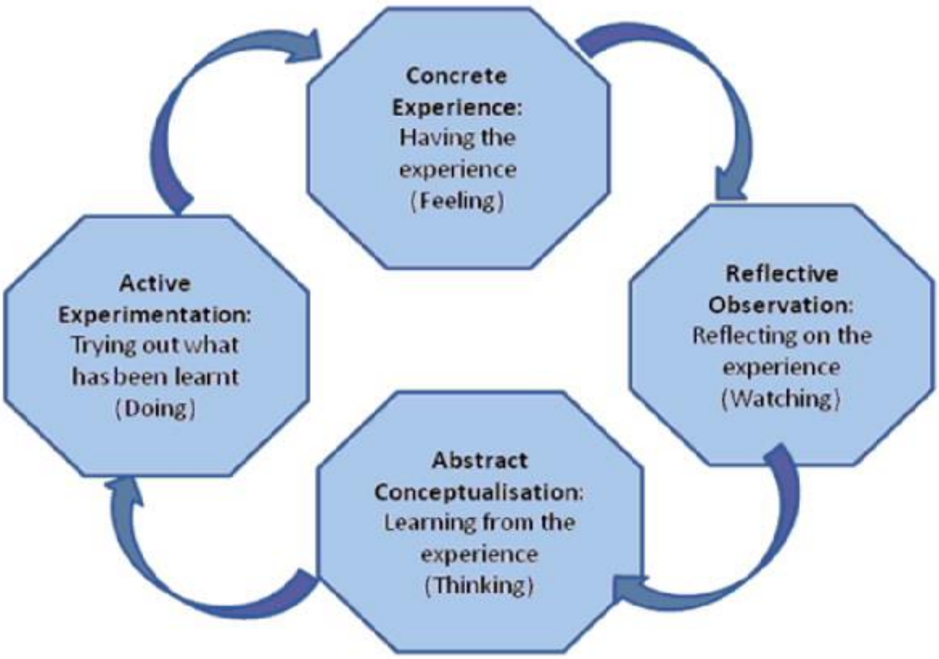


Figure 5.49 Experiential learning according to Kolb (1939)

Heron states that “Experiential learning takes place through an active and aware involvement of the whole person – as a spiritual, thinking, feeling, choosing, energetically and physically embodied being. The person also exists as part of a society with its norms and values” (1989: 11). Figure 5.22 shows that movement and being active can be memorable; for example, the drawing of ‘what happened on the trip?’ by this child only showed parts of the environment exploration trip where she had to move or interact in some way. Figure 5.50 shows a class teacher commenting on the memorable nature of live animals for her class.

Figure 5.50 Post-visit interview explaining the salience of live animals

Heron (1989) acknowledges that senses collect information to interpret. However, proponents of this approach assume that the person has chosen what they do, which is not true for most school children. One implication of this research is the recognition that free choice learning allows children to explore and form cognitive maps of a new space, satisfying what some see as a basic need to characterise a new environment when they are in a state of high alertness. City children do not often get the chance to explore within a safe place, and this may be why children found moving through a space memorable and enjoyable as indicated in the Section 5.2 about environmental exploration. This is similar to Falk et al.'s (2007) conclusions about the importance of free choice learning in museums.

Embodied Learning (Burwood, 2006) goes further to acknowledge the learner's immersion in the learning process and, in contrast to experiential learning, it involves the learner in identifying their learning and participating in reflecting on how new experiences have transformed their viewpoint. O'Loughlin (2006:82) suggests there are *creatural dimensions* of human beings as "a set of multisensorial powers knowing a world which, while it limits and sometimes firmly resists, is nevertheless shaped and altered in the service of human ends. Embodied human perception therefore consists of the interaction with its environment". There are two premises:

1. Human beings live in their senses. They create a representation of environment around themselves through perception.
2. An ecological model of subjectivity which relies particularly on the phenomenological sense of place, the notion of body intentionality and the relationships between and among all kinds of bodies which constitute specific sites for action.

(p59)

O'Loughlin considers that our interaction with the world is not Cartesian (i.e. has mind-body dualism, separation), but more like physics where, as demonstrated by wave/particle duality, how you look determines to some extent what you find: "Thus, our research through our senses is an holistic and phenomenological process" (2006:14).

It is clear that there is support in the literature for a theory which integrates cognitive and sensory factors in assigning attention. How, then, is the new information processed by the brain?

5.7.8 Processing salient information for learning

Ehrenzweig (1987) suggests there are three models of accommodating new experiences:

1. Fragmentation. The person overrides existing model of understanding (de-differentiation) and tolerates new potentials and the anxiety this may cause. (I.e. What if what I have thought was true, and based my decisions on, is actually not the case?)
2. The learner takes a broad scanning view, and allows new connections to emerge and be formed through synthesis, making cross-links.
3. Re-introjection/integration, where there is a conscious awareness of a new whole.

Rather than presenting a flow chart with three such alternative ways of processing, I ascribe to views which are more cyclical. For example, a foundation model for this is Kolb and Fry's Experiential Learning Cycle (1975) as shown in Figure 6.52. Although viewed as simplified, it is a good way to consider how the senses contribute to the experiential learning cycle:

1. Concrete experience and awareness. A stimulus provokes awareness of a new experience. If it is not particularly salient, it will require conscious effort to attend to. For example, reading new information, it does not jump out instantly, but cognitive factors lead the reader to conclude that it needs attended to. Alternatively, a salient stimulus which is attended to from the sensory point of view would be an animal in one's field of view, something that would elicit curiosity.

2. Observation and reflection. At this point, the filtering power of the brain is applied. The learner reflects on concrete experience and compares it to existing knowledge. They may gather new evidence to mapping relationships, and this is how questions would arise.

3. Formulation of abstract concepts. New generalisations and tentative hypotheses form; for example, consider children thinking about the concept 'nature'. Does this include pets? Is it all animals? Experience and evidence would lead them to refine their exemplars. Analysis and assimilation are more likely to involve the critical reasoning part of the brain than is gathering more sensory information.

4. Testing implications and concepts. Finally, learners try out new conceptual idea with new examples, essentially asking: 'What happens if I do this?'. In children, it was seen as they shared information with peers and teachers in a process Doris Ash (2007) refers to as thematic continuities, seeking to better understand language and concepts through trying out sequences of words. However, in practice learning doesn't always take place in a cycle or linear order, so this process may take a long time.

Questions about assimilation of new information which are relevant to this model are: how would it vary with age? How resilient are concepts? Are fast learners early adopters, and does this mean they are quick to jettison old information which may in fact subsequently prove useful? How do facilitators influence this assimilation process so that they can help children progress within their zone of proximal development? Bandura (1977) undertook research which showed that there is a role for imitation of competent others in this type of learning, which links to the code 'repetition' in the skill domain.

Learning set within cultural norms implicates Critical Theory about the role of socialisation. For example, Lave and Wenger use the idea of situated learning (1991) to extend themes of place-based education and incorporate critical approaches to understanding the prominence of society and culture in the mediation of learning. They see learning as a process that takes place in a participation framework, not in an individual mind. Important, though, as participation is, learning can take place in a context that does not include other people. Likewise, from a social constructivism perspective (e.g. Burr 2003), situated learning is criticised because the individual is ignored to an extent. This lead Alheit (2009) to propose *biographical learning*, which is learning entirely from an individual's perspective, like themes of *personalised learning* which have arisen in recent formal assessment discourses in England (Miliband, 2006). Personalised learning takes a more holistic view of the learner, which incorporates their existence in both the realms of formal and informal education. The majority of children's waking time is out of school (Bransford et al., 2006). They state:

> Often times learners are left to navigate in different settings of learning without adequate support and without the recognition of the importance of communication and social interaction as vital mediators of learning … there is clearly a need for the development of pedagogical models, solutions and activities that can best support learners' meaningful transitions and participation in formal and informal settings of learning. The funds of knowledge developed in one setting should become the resources in

> another. This is likely to increase learner's agency and active engagement in learning that stretches beyond settings and contexts.
>
> (2006: 112)

Bransford et al. propose *dialogic learning* as a way to provide cultural bridges to participate meaningfully and powerfully in spaces beyond the classroom using three settings: a forest, a museum and a science centre. Dialogic inquiry is a pedagogy where there are multiple positions of authority and identity, allowing negotiation and dialogue for the social construction of meaning. There is potential in this pedagogy as a vehicle for *participatory learning*, but true engagement is challenging. A high level of subject knowledge and expertise is required from the teacher.

I would see this as evidence for the need for informal and formal educators to collaborate closely in the preparation for a school trip. Likewise, following a trip, understanding is needed by the educator of the ways that children's learning is assessed by the teacher; for example, see the children's written recounts of the live animal shows and the teacher post-visit interviews earlier in this chapter.

The idea that learning can be transferred between settings is known as *boundary crossing* (Bransford et al., 2006; Walker and Nocon, 2007). There is a wealth of research into settings, but little on how students cross between settings, what they apply from one situation to another, and how they engage with the different modes of interaction. This has an implication for future research; whilst I looked at learning in the different settings, I did not consider the boundary crossing between settings. Greeno (2006) suggests that the competence to function in multiple settings is developed whilst pupils are positioned in activity systems where they are framed as authors of their own learning, i.e. free choice learning in different settings would be likely to be more beneficial to learning in terms of developing flexibility to learn in different informal settings. Greeno notes that when schools are connected to community networks, pupils are more likely to acquire the learning tools needed to interact in a range of settings.

In a sociocultural framework, learning is not just a matter of epistemology, but also a matter of ontology, the development of agency and identity (Packer and Giocoechea, 2000). Brown and Renshaw (2006) undertook a "chronotopic analysis of dialogic inquiry practices" in which they looked they look at how students "shape the space-time contexts of their learning environments" (p116), meaning how they refer to other times and places when they are learning in one setting. I think this avenue of research is worthwhile, although I am concerned by their findings which were drawn from analysis of a small sample (18 children) in Finland and claim support for dialogic learning despite their evidence focussing on issues which seem to me (as having been both a formal and an informal educator) to be examples of misbehaviour by children. Nonetheless, the theoretical justification of investigating boundary crossing in different informal settings is an area which would be useful to pursue. For example, Falk et al.'s (2011) 'ecology of learning' is referred to as a way of describing the way that informal learning experiences interact to contribute to transformative learning for individuals and groups within a community, as explained in the literature review (Chapter 2).

5.7.9 Transformative learning

Transformative learning (Cranton and Taylor, 2012) entails a deep shift in perspective during which habits of mind become more open, more permeable and better justified (Mezirow, 2000). Dirkx (2001) takes the position that affective domains, imagination, intuition and emotion, are at the heart of transformative learning. It happens when an individual or group encounters a perspective that is at odds with the prevailing perspective. If it is ignored, nothing happens. If it prompts re-examination of beliefs, values or assumptions, then transformative learning occurs and learners experience changes in their understanding of meaning. Mezirow (1991) explains three types of meaning perspectives: (1) epistemic (about knowledge and how we get it); (2) sociolinguistic (understanding ourselves and the social world through language); and (3) psychological (to do with the perception of ourselves based on childhood experiences). We uncritically assimilate perspectives until we encounter a dilemma that brings a distortion to our attention. From a theoretical perspective transformative learning assumes constructivism, that the learner is an active participant. Transformation can be rational, extrarational or social.

Rational transformation has the individual as its unit of analysis. It draws on the 'innate' drive to understand and make meaning of surroundings (thought to be a survival mechanism). What is transformed is the individual's frame of reference, structures of assumptions and expectations that frame an individual's tacit points of view and influence their thinking, beliefs and actions. These include habits of mind such as habitual means of thinking, feeling and acting influenced by underlying cultural, political, social, educational and economic assumptions about the world. They get expressed in a point of view. They often develop uncritically in childhood through socialisation and taking on family, teachers' and other significant people's points of view. Frames of reference act as filters when interpreting experience. Therefore, this explains how there can be a cyclical relationship between stimulus perception, cognition and repeated stimulus perception (influenced by altered cognitive attention focussing). When experience does not fit an existing frame of reference then there is a rejection of the frame of reference, or a paradigm shift, a transformation in thinking.

Extrarational transformation refers to an older view of transformation through learning. Boyd and Myers (1991) called on Jungian psychology to explain transformative learning. They emphasise the importance of the group in supporting people working through transitions. Dirkx explains the experience of emotional dynamics in learning comes from:

> largely unconscious issues evoked by various aspects of the learning setting, such as the self, designated leaders, other learners, the context in which learning occurs, and the task that is the explicit focus of our learning
>
> (2006:17)

Social transformation has as its unit of analysis the individual in society. Cunningham (1998: 16) explains that it is “contextualised in the history, culture and social fabric of the society in which he/she lives … at the intersection of the personal biography and societal structure”. Interpreting this through the lens of Critical Theory means that the difference between this and previous similar statements is that the learner is aware of the influence of the previously mentioned factors on their agency.

In practice, this means that transformative learning involves helping learners move from a simple awareness of their experience to awareness of how they are perceiving, thinking, judging, feeling and acting, enabling them to reflect on actions based on this experience, e.g. how they will look at things in future. Practically, Cranton and Taylor (2012) suggest that there are six factors for educators to take into account: Individual experience, Critical reflection, The role of dialogue, Authentic and supportive relationships, Holistic orientation and Awareness of context. Transformative learning is often used as a term in adult learning but I feel the rhetoric of transformative learning is applicable to informal learning.

5.7.10 Salience in non-educational fields of research

In the interests of thoroughly researching this theory in a cross-disciplinary and boundary-crossing way, I have investigated literature about salience from the fields of computing and military research. Caine and Caine (2011), in their deceptively titled book *Natural Learning for a Connected World* are attempting to engage the luddites of environmental education by suggesting that technological learning processes are universally applicable and natural. This is a Californian book (so, influenced by the norms of Silicon valley) that takes a defensive stance in respect of information technology, showing how technology learning is linked to natural learning processes. It is noteworthy that interconnectedness and systems thinking about ecosystems occurred at the same time as computer network development was first conceived, around the 1960s. It is interesting that conceptions of the environment are also linked to technology, like analogies with memory now and in the past (when Aristotle compared the workings of the mind to chariots). Caine and Caine summarise the argument that educators have to go beyond transformative learning in the knowledge domain:

> Educators have to let go of much of the control that comes with being the content expert in a classroom and being responsible for everything that happens. … the information age requires educators who can lead learners into their unique interests, talents, understandings and expertise, while simultaneously embedding and dealing with the academic, social and emotional capacities that students have and for the future they will face.
>
> (2011:23)

Relevant to this theory, they explain the 'Perception/Action Dynamic' as a foundation for learning from life, citing Pearce (2002):

> In the earliest period of infancy, for instance, the prefrontal lobes develop parallel to the growth of the sensory motor system … If however, the child's environment does not furnish the appropriate stimuli needed to activate pre frontal neurons … the prefrontals can't developed as designed. The cellular growth itself becomes compromised and faulty.
>
> (2002:47)

Meltzoff et al. (2009) also explain the perception/action cycle:

> in order to survive in, and adapt to the world, all human beings are constantly engaged in a dance of perception and action. They have to gather useful information about their environment and themselves using their senses (perception), and based on this information, they have to manipulate their environment, themselves, in a way that is advantageous.
>
> (p49)

Meltzoff et al. explain the problem of the vast number of environmental stimuli in terms of these being organised into recognisable patterns, e.g. a car. Hayward (1998:3) views the relationship between perception and cognition differently to the model I have proposed, stating that perception and action in the real world form the foundation for cognition. I would assert that both perception and cognition drive movement (action). For example, someone might escape a negative stimulus using a reflex response, or may move towards a positive stimulus guided by cognitive interpretation. Gopnik et al. (1999:51-2) state that "all children have an explanatory drive that sparks their search to understand how the world works, and that interaction with consistent patterns shapes how children act, react and respond to the world around them and who they become, and prepares them for further development". Damasio (1999) adds that the emotions are also important in the perception/action cycle. Joaquin Fuster (2004) describes the perception/action dynamic as including time to reflect, to organise and to categorise new information.

To take a neurophysiological perspective, Engel (2009:9) explains how young children learn, stating that they are like explorers. On the relationship between the brain and the mind the following learning principles are proposed:

- All learning is physiological.
- The brain/mind is social.
- The search for meaning is innate.
- Emotions are critical to patterning.
- The brain/mind processes parts and wholes simultaneously.
- Learning involves both focused attention and peripheral perception.
- Learning engages both conscious and unconscious processes.
- There are at least two types of memory (episodic and semantic, declarative and non-declarative).
- Learning is developmental.
- Complex learning is enhanced by challenge and inhibited by threat associated with helplessness/fatigue.
- Each brain is uniquely organised.

(2009:12)

Vidyasagar (1999) provides neuroscience research to show "attentional feedback that highlights neural responses as early along the visual pathway as the primary visual cortex. Such filtering would help in reducing informational overload and in performing serial visual search by directing attention to individual locations in the visual field" (p66). This is a neuronal model of the attentional spotlight theory. This model builds on earlier work by Posner et al. (1980) about signal detection and attention. They found that cueing learners to watch the site where a salient stimulus would occur improved the detection rate, therefore strengthening the argument that higher cognitive function can affect attention direction. The implication for educators is that it is worth pointing something out!

Situation awareness

Situation awareness is a field of research which arose from a military perspective, and refers to the perception of environmental factors in space and time, understanding their significance and being able to plan how they will or could change in future. It requires understanding and learning the factors which represent a normal scenario, then being aware of any changes, such as new stimuli or the absence of usual objects, which may require analysis and response. It applies also to emergency services, and complex situational roles such as air traffic control. The principles of heightened attention in new situations could equally be applied to children visiting a new place during a school trip.

5.7.11 Summary

This Section has explained thinking about informal learning with reference to the learning process, specifically the sensory and cognitive processes by which learning takes place. Evidence has been described to demonstrate that thinking about learning in this way is not novel in the fields of learning, or even in computing and military research. However, elements have not been combined in this way for informal learning previously, as far as the author is aware.

Figure 5.54 could be used by informal educators to help understand how salient a set of stimuli has the potential to be. Although it is reductionist, it is intended to aid educators in reflecting on the salient aspects of their informal learning environment, and therefore in considering improvements to pedagogy. This could be researched further in future.

<table>
<tr><td rowspan="9">Sensory</td><td rowspan="9">Physical attributes</td><td>Colour – hue</td><td></td></tr>
<tr><td>Colour – intensity</td><td></td></tr>
<tr><td>Size</td><td></td></tr>
<tr><td>Pattern</td><td></td></tr>
<tr><td>Shape</td><td></td></tr>
<tr><td>Sound</td><td></td></tr>
<tr><td>Smell</td><td></td></tr>
<tr><td>Texture</td><td></td></tr>
<tr><td>Movement</td><td></td></tr>
<tr><td rowspan="10">Cognitive</td><td rowspan="3">Emotion</td><td>Fear</td><td></td></tr>
<tr><td>Excitement</td><td></td></tr>
<tr><td>Humour</td><td></td></tr>
<tr><td rowspan="4">Social signpost</td><td>Parent</td><td></td></tr>
<tr><td>Peer</td><td></td></tr>
<tr><td>Teacher</td><td></td></tr>
<tr><td>Educator</td><td></td></tr>
<tr><td rowspan="2">Prior experience</td><td>Novelty</td><td></td></tr>
<tr><td>Familiarity</td><td></td></tr>
<tr><td>Imagination</td><td>Perceived authenticity</td><td></td></tr>
<tr><td>ental</td><td>Novel</td><td></td><td>x2</td></tr>
</table>

	Familiar		x1
		TOTAL	

Figure 5.51 Proposed numerical model for investigating the salience of an experience

5.8 Conclusions

This thesis has presented research investigating what children learn about biodiversity in three different settings: an environment exploration, a live animal show and a natural history collection in a museum. The study involved eight primary school classes (two in the pilot study and six in the main research), with a total of 240 pupils aged 8 and 9.

This research is original because the choice of question, methodology and comparison of three settings are new. The study used mixed methods: a pre-/post-visit activity, video recording using pupil-perspective headset cameras, and interviews. Additional evidence, in the form of children's drawings, was also presented. Analysis was based originally on the MLA framework 'Generic Learning Outcomes' including the domains Enjoyment, Inspiration, Creativity, Activity, Behaviour and Progression, Attitudes and Values, Knowledge and Understanding and Skills. The pilot study compared the responses of two classes at the Natural History Museum in London; one class had visited a specimen handling session together with a wildlife garden activity; the other class had visited only the wildlife garden. At this early stage (February 2012) microphones and camera stills were used to gather qualitative information. The pilot study showed that the MLA framework was not ideal for analysing activities about nature, and instead Nichols' and Zeidler's (2012) framework 'Earth Smarts' was chosen. This includes domains of skills, place, attitudes and knowledge, the subdomains of which had been specified as those which are involved in socioecological literacy.

The main phase of data collection took place in Summer 2012 at sites near King's Cross: Camley Street Natural Park and the Royal Veterinary College. Video recordings were taken using pupil headset cameras and wide-view recording. Six classes undertook trips where they visited two sites from the following options: Environment exploration, Museum specimen collection and Live animal show. All six combinations of two visits were covered. This allowed identification of different responses in groups of children who had experienced different settings. As a result of initial data analysis, a new domain, 'Emotion', was added to the Earth Smarts framework.

The results and discussion approach the data first by domain, and then by setting. Results have been conceptualised in five domains: Skills, Place, Emotion, Attitudes and Knowledge (SPEAK). The most common types of learning observed overall were species name, motivation, description, species behaviour and what livings things need.

There is evidence that the environment exploration was the source of considerable motivation for children. I suggest this is related to the surprise of discovering wildlife in authentic situations. The freedom in sessions allowed children to develop consensus about, for example, identification, through a process of disagreement when encountering unknown species. The environment exploration session presented the most interconnected view of nature. Nature was most likely to be seen as a scientific subject in this context.

The live animal shows led to children describing species, and subsequently recalling aspects of individual animals' personalities. Sessions raised ethical questions for children about where the animals came from. The session developed handling and classification skills, and the connection between the presenter and the animals led to children believing that they should take personal responsibility for nature. Nature was most likely to be seen as related to literacy in this context.

Natural history specimen collections developed skills of observation, identification, discovery and reading. Children learnt species names and specific vocabulary. Sessions allowed development of attitudes about career choices. Free exploration allowed children to show others species they had found, and to disagree over the name of novel specimens. Children were more likely to see nature as something that someone else should look after.

Overall, there is evidence that different ways of learning about biodiversity are complementary, and that by accessing more than one type of biodiversity education children will develop a more holistic understanding. This is supported by, for example, museum educator James' comment on the effect of combining live animal and museum sessions (Figure 5.52).

Figure 5.52 Post-visit interview: combining sessions

Understanding the inter-relationships between species is seen to be crucial for young people to be able to engage in contemporary debates about resource use, which are significant in future long-term sustainability. Biodiversity education has been a source of debate in recent years, for example, at the 'Rio +20' conference in Brazil, 2012, where lack of biodiversity education success was identified as a cause for concern, specifically lack of progress towards expected resource protection targets. This research provides a conceptualisation for informal biodiversity educators and related organisations to reflect on children's learning and identify if the values and key messages they are conveying are those which they intend.

I recommend that educators analyse their activities using the SPEAK conceptualisation of learning, and understand where the majority of learning is taking place, reflecting on whether that is what they intend. Georgina Keeler, PGCE student, carried out this exercise with Natural History Museum workshops (Keeler, 2012), and concluded that there was a need for more dialogue. Section 5.5 includes a case study of using iPads in communicating the value of informal education using the SPEAK domains, which could be used by other organisations in future.

Children's concepts of nature and their relationship to wild spaces is discussed in Section 5.6, with the conclusion that educators need to be more aware of the plurality of viewpoints with which children approach the concept of a natural space. This is relevant to movements such as 'Project Wild Thing', an organisation attempting to reconnect children to non-screen time. At the time of writing, they have approximately 1500 organisations, including the NHS, signed up as recognising the importance of outdoor experiences for children. Future research could further investigate the diverse prior experiences children bring to the concept of 'natural places'. 23% of children did not have an answer to the question 'Is there a natural place you particularly like?' and reasons for this could be further investigated.

The aspect of this research which I am most interested in researching further is the concept of a Salience Theory of Informal Learning. This has been proposed after considering which aspects of an informal session were most memorable for children. This could be usefully investigated, in the fields of learning research and neurobiology. How people learn information about their environment is not well understood. Understanding how children conceptualise a space is important to understanding the benefits of taking them to a new space.

It is important to remember that the discussion here refers to results that were observed with a limited sample of primary children in central London. Conclusions about children's learning are therefore limited to urban settings. The examples of a museum, an environment centre and live animals are also highly specific, including setting, staff and resources. However, it is intended that this research is a basis for discussion and further work, acknowledging the constraints of the scope of this study.

This thesis has presented distinctive contributions to knowledge about informal learning by a) characterising and comparing primary children's learning about biodiversity in a museum, environment centre and at a live animal show; b) defining a conceptualisation of informal biodiversity learning; c) showing how this conceptualisation can be used to evaluate learning using iPads; d) presenting urban children's understanding of the concept of natural places; and e) proposing a Salience Theory of Informal Learning. This theory integrates aspects of neurobiology and mapping, and relates to research in the fields of authenticity and imagination; future research is needed to investigate this concept more thoroughly.

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Appendix A: Presentations and Publication Information

Selected Presentations

- Higher Education Academy 12/13. London, UK. ‘Using iPads for educational evaluation at the Royal Veterinary College’.
- British Educational Research Association 09/13, Brighton, UK. ‘Pupil perspectives on Biodiversity’. PhD research presented as poster and presentation as part of Early Career Researcher Conference.
- World Environment Education Conference, 06/13, Marrakesh, Morocco. Presented PhD research ‘Biodiversity Education in London’ in French and English as part of Research and Pedagogy strands.
- STORIES, 03/12, Dept. of Education, University of Oxford, UK. Presented PhD research ‘Pupils and Biodiversity’.
- European Association of Science Centres 06/12, Toulouse, France. ‘Bringing Natural History to Life’ PhD research presentation with Universeum, Gothenburg. Session co-ordinator for ‘Demystifying Biodiversity for Children’ with University of Montpelier, Royal Belgian Institute for Natural Sciences and Bristol Natural History Consortium.
- Public Communication in Science and Technology, 04/12, Florence, Italy. ‘Emerging Models of engaging children in Science’. Proposed and wrote seminar involving Natural History Museum, Science Museum and EU UNAWE speakers.

- Smithsonian National Museum of Natural History invited attendee 02/12 to conference '21st Century Learning in Natural History Settings (included zoos, botanic gardens, aquaria and museums).
- Winston Churchill Memorial Trust awarded travelling fellowship 12/11. Sharing and exchanging innovation in nature education with museums, zoos and environment organisations in Sydney, Australia and Auckland, NZ.
- British and Irish Association of Zoos and Aquaria Conference Paignton Zoo, 11/10 Linking Scientists and Schools (also shown at Communicate Bristol Natural History Consortium, 11/11).
- Association for Science Education conference, Reading University, 06/10 Workshop 'How to use natural history to inspire pupils'.
- Handheld Learning, Westminster, 10/07 Using mobiles to identify wildlife (wrote and illustrated PDA program).

Selected Publications

- 'Biodiversity Education in London', 06/13, Proceedings of the World Environment Education Conference.
- 'Using technology in environment education', 03/13, National Association of Environment Education journal.
- '100 years of Learning at the Natural History Museum', 10/12, Evolve, Natural History Museum magazine.

Appendix B:

Kimble, G. (2014). Children learning about biodiversity at an environment centre, a museum and at live animal shows. *Studies in Educational Evaluation*,*41*, 48-57.
This paper presents some of this thesis' research, using the author's previous name of Kimble.