

Nature literacy: rethinking how we teach about nature in secondary school science

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Abstract Our connection with nature is important for mental and physical well-being and this connection depends on how we understand, value and engage with the natural world. However, there is persistent evidence that young people remain disconnected from nature. In this article we discuss reasons why many secondary schools in England are having difficulty engaging their students with nature. We propose a rethinking of the way we teach about nature and biodiversity by promoting the notion of ‘nature literacy’, which can empower students to become more actively engaged with the natural world around them.

We live in a time when plants and animals are disappearing at an unprecedented rate owing to human development (United Nations, 2020), and yet there are persistent reports that children are becoming increasingly alienated from nature (Bruni *et al.*, 2017), and there is widespread concern that this can have serious mental health and behavioural consequences (Soga and Gaston, 2016). It is therefore hugely important that we do all we can to encourage today’s young people, as future guardians of the planet, to care for the natural world around them.

The naturalist Robert Michael Pyle (2003) stressed the value of small and urban settings and ‘wild nooks’ and ‘marginal urban waste ground’ in connecting with nature, asserting that ‘*It is the opportunity for the young to explore, dig, prowl, play, catch, and ultimately discover, among indigenous local plants and animals, that truly forges connection*’ (p.208). As well as being fun, these kinds of activities also provide a chance for young people to learn about the natural world around them, and in this article we argue that this is the basis for developing ‘nature literacy’ among students; even schools in confined urban spaces can provide some humble wild nooks for such experiences. We start by looking at the underlying practical difficulties with engaging students with nature in today’s secondary schools.

Why isn’t school science engaging students with nature?

We believe that there are two main reasons why many secondary schools in the UK have difficulty engaging their students with nature:

- teachers’ predispositions towards nature and fieldwork;
- the lack of emphasis on nature and values in the school science curriculum.

We explore these multifaceted reasons below.

Teachers’ predispositions towards nature and fieldwork

In a survey of over 2000 heads of department in English secondary schools, O’Donnell, Morris and Wilson (2006) found that children at schools with lower levels of achievement and schools with higher levels of deprivation were less likely to have opportunities for education outside the classroom. They deduced that one of the main reasons for this limited outdoor opportunity was the lack of teacher confidence. Scott *et al.* (2015) argue that some teachers’ predisposition towards being out of doors is a critical influence on fieldwork provision in schools. Many science teachers lack knowledge about nature and lack the confidence to teach fieldwork (ASE, 2011). The importance of ecological fieldwork in the teacher-training curriculum has diminished in recent times (Tilling, 2018), and there is a wide discrepancy of delivery among teacher-training providers (Lock and Glackin, 2009).

Nature and values in the school science curriculum

Despite various initiatives over the years to create cross-curricular subjects such as environmental education, school curricula around the world still tend to place nature-related topics, such as biodiversity, nature conservation and education for sustainable development, within two subjects: geography and science. The term ‘nature’ is absent in the science National Curriculum in England (Department for Education, 2015), although there is explicit inclusion of the ecological and environmental science knowledge content associated with nature (e.g. adaptation to the environment and how species

interact with each other and with humans). However, truly meaningful engagement with nature requires students to consider how the underpinning scientific knowledge is inevitably intertwined with human values. We sometimes overlook this because our values can be so deeply entrenched that we can forget they exist. Slater (1994) regards values as strongly held, long-lasting attitudes to which we are profoundly committed, and, as science is carried out by scientists who (being human) are influenced by their own values, we argue that science and values are inseparable. For example, real conservation biology is driven by the value of biodiversity to humans, which puts human values at the heart of conservation science decision-making (Grace and Hare, 2008), and students need to be aware of this.

Values and emotions are actually included in the secondary science curriculum for England (Department for Education, 2015). The overall 'Purpose of study' states 'Through building up a body of key foundational knowledge and concepts, pupils should be encouraged to... develop a sense of excitement and curiosity about natural phenomena'. The 'Working scientifically' section for key stage 4 promotes evaluating 'personal, social, economic and environmental implications [of science]; and making decisions based on the evaluation of evidence and arguments'. And the section on 'Ecosystems' requires that 'Students should be taught about... the importance of biodiversity'. However, these values-related statements are often overlooked, or only touched on briefly, possibly because they are considered more difficult to assess than subject-knowledge content.

To understand the importance of biodiversity, students need to consider values: its value to people. We recently explored students' understanding and views on the importance of biodiversity, by surveying two

whole-year groups of 11- to 12-year-olds ($N=556$) from a suburban school in Southampton (i.e. children across the range of abilities, and ethnic and socio-economic backgrounds). The students had just completed the topic of ecology and biodiversity and participated in a one-day fieldtrip to a local nature reserve, where they discussed the site's conservation plan with the ranger and carried out ecology-related activities. These students had therefore received much more teaching about nature than most students in English schools. Having completed the topic, we asked them to give an open written response to the question: 'What is the point of protecting biodiversity at [the site]? Give as many reasons as you can think of.' The question was purposely phrased slightly provocatively, as some researchers believe that provocative questions can stimulate people to think more deeply about an issue and encourage them to think creatively and laterally.

We then categorised their responses according to the kinds of values they gave. We found that the students had a good basic understanding of the meaning of biodiversity (i.e. as being the variety or number of species within a particular area), and the vast majority (93%) mentioned some science knowledge-based reason for the importance of biodiversity, mostly in relation to what eats what (i.e. food chains and food webs). However, as shown in Figure 1, they struggled to give value-related responses, even though they were told that they could mention anything, not just scientific responses. Only 58% mentioned any values at all. A small number (16%) raised biocentric values (e.g. student 157: 'All animals have a right to live'); and the most common anthropocentric (human-centred) value was in relation to human health and well-being, which was only raised by 21% of students (e.g. student 104: 'Because we need trees and plants for oxygen'). The students mentioned the

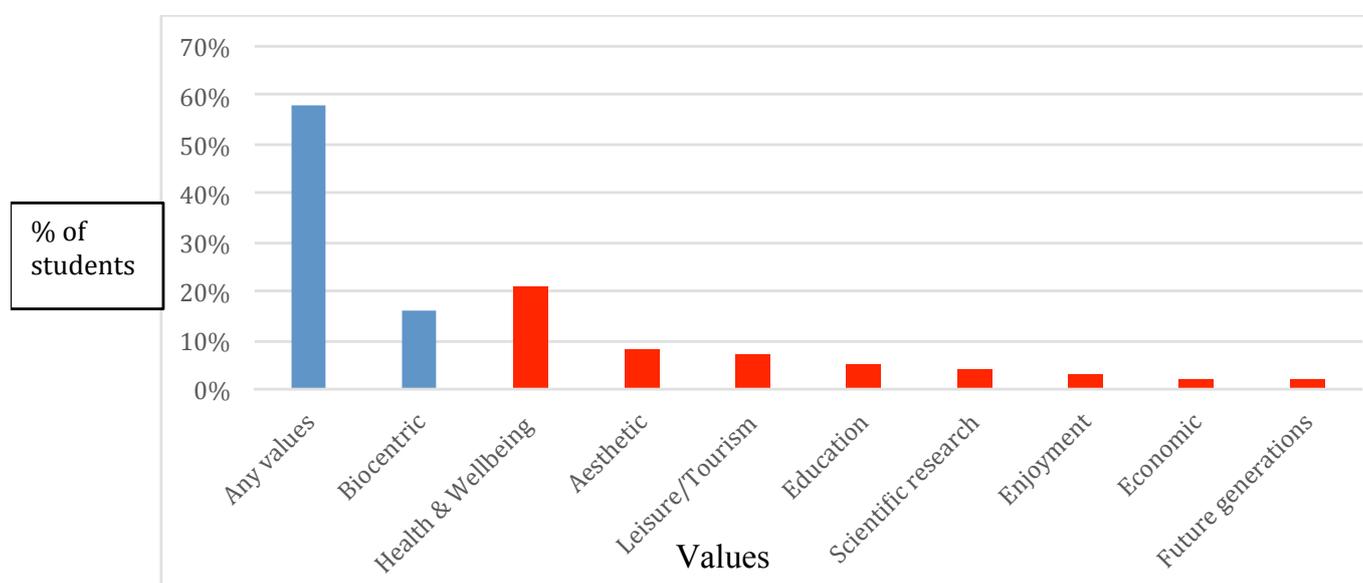


Figure 1 The percentage of students ($N=556$) raising biocentric and anthropocentric values about the importance of protecting biodiversity (anthropocentric values in red)

importance of protecting biodiversity for food, medicine and ultimately for human survival. Interestingly, a substantial number of students (17%) raised an apparent misconception that a biodiverse site produces more oxygen for animals and humans than a less diverse site, whereas some fast-growing monocultural tree species can sequester carbon faster than native mixed woodland species.

Nature literacy: engaging students with nature

It is clear that we need to find ways of overcoming the barriers described above to enable students to engage with nature, but we also need to consider what we mean by ‘engagement with nature’ and how to achieve it; we propose the notion of ‘nature literacy’. Nature-literate students have the ability to engage with nature, both cognitively and emotionally, and feel empowered to take some form of positive action to benefit nature. This definition has parallels with the concept of ‘health literacy’ as described by Nutbeam (1998: 357), who believes that knowledge and values are critical factors for health literacy: ‘*By improving people’s access to health information, and their capacity to use it effectively, health literacy is critical to empowerment*’. We make the same argument here for engaging students with nature; that is, providing access to information about nature and nature conservation (both science and values-related information), and the ability to use that information outside the classroom, can empower students to become more actively engaged with the natural world. The aim of nature literacy is, of course, not necessarily to train students to become professional ecologists or conservation scientists, but to raise awareness of the importance of nature conservation across the diverse range of students so they better understand and actively support conservation programmes as they grow up through the 2020s.

Our connection with nature

Human beings co-evolved with other living things in the natural environment, and this is the basis for the biophilia hypothesis (Kellert and Wilson, 1993) postulating that our ancestors were those more connected with their natural surroundings because they would be more likely to survive and thrive and would have a consequent evolutionary advantage. This has left us with a deep, inherent connection with nature, and we are adapted to function well when exposed to the natural world. Despite this innate connection, some researchers, such as the environmentalist David Orr (1993), believe that we need positive exposure to nature during childhood in order to develop biophilic tendencies.

Several ways of measuring ‘nature connectedness’ have been proposed, and a widely used scale recently developed by Natural England is the Nature Connection Index, which, in our view rather disappointingly, does not include aspects of knowledge and learning. The developers state that ‘*The scale did not set out to measure cognitive aspects of nature connection as evidence suggests that it is the affective elements that are more likely to be important in relationships between nature connection and wellbeing*’ (Natural England, 2017: 5). We are hard-pressed to find anything more than anecdotal evidence for this, and believe the cognitive–affective differentiation of values to be a false dichotomy. We all vary in terms of what engages us with nature, and these preferences are often based on which aspects of nature we feel provide the most stress-releasing, restorative benefits. In our view, something often overlooked is that many people (including children) have a positive emotional response to learning and increasing their knowledge about nature, and this cognitive aspect itself can stimulate a feeling of connectedness with nature (Grace, 2020). That people receive emotional satisfaction from learning is evident by the huge popularity of quizzes on television, online and in pubs. The same response can be found when valuing nature: Sir David Attenborough’s immensely popular documentaries, such as *Our Planet*, provide us with a carefully crafted blend of emotion and learning.

Motivating students to engage with nature

Our actions and behaviours depend on motivation: extrinsic motivation, which is driven by external influences, and intrinsic motivation, which arises from within and refers to gaining inherent satisfaction from the activity itself (Ryan and Deci, 2000). These motivators can be positive or negative. For students, positive extrinsic motivators may include grades, rewards or satisfaction from pleasing the teacher. Negative extrinsic motivators can include the fear of what their peers might think of them and, in the context of engaging with nature, this could be worrying about how they might perform outside the comfort of their classroom. The teacher therefore needs to build their students’ confidence in this respect. Intrinsic motivation is personally rewarding and triggered by such things as personal values, interests and curiosity. Fear of nature is a significant negative intrinsic motivator because children with little prior experience of the natural environment will understandably have a fear of the unknown. If this fear is not addressed it can lead to alienation from nature. Another negativistic feature that has emerged in recent years is ‘ecoanxiety’, described by the American Psychological Association as ‘*A chronic fear of environmental*

doom' (Clayton *et al.*, 2017:68). It can result in feeling helpless to do anything about nature and the environment at a personal level, and that the only option left for easing anxiety about nature is to disengage from it.

Teaching for nature literacy

To encourage students to engage fully with nature and become nature, we need to provide them with the opportunity to experience some outdoor fieldwork, even if it is within the confines of their school grounds. As well as the physical and mental health benefits of being outside, there is considerable evidence that well-designed and implemented fieldwork can benefit '*student motivation; discipline-specific knowledge and understanding; integration of theory and practice; development of practical and technical skills; acquisition of generic skills in areas such as teamwork, autonomous learning, critical thinking and communication*' (Tilling, 2018:539). It is also essential that all students have this opportunity. In England, children living in lower income areas and children from black, Asian and other minority ethnic backgrounds are less likely to spend time outdoors (Natural England, 2019), and this makes schools all the more important as places that enable children from all backgrounds to experience nature.

Based on our own experience and education research from around the world, we have recently had a rethink about how we teach about nature literacy, and this new approach has already met with considerable success with our trainee science teachers and students from a wide range of ethnic and socio-economic backgrounds at urban and suburban secondary schools. It includes the following key features:

- Take a constructivist approach by getting to know something about the students' backgrounds and interests and establishing how much (or how little) they know and care about nature, and start building their knowledge and experience from there.
- Provide basic scientific information about the site. Prior to the fieldwork, set the scene for the students by giving them a clear idea of what kind of plants and animals to expect, and also allay any fears they may have about what to expect generally (see Box 1) and how to carry out the scientific activities. This will require teachers to familiarise themselves with the site and its biodiversity. Modern technology offers teachers who have difficulty in identifying organisms many excellent online identification guides and free apps for phones, which can instantly identify species with considerable accuracy simply by taking a photograph.
- Provide values-based information about the site, such as authentic information about the history and social, economic and cultural aspects associated with the site. Anecdotes and fictional or unsubstantiated stories about the site can also serve to interest and motivate students, but it is important that they know which 'stories' are evidence-based and which are not. Furthermore, there is something unique to learn about all plants and animals (they all have their own story); the websites of wildlife organisations are good places to explore these.

Box 1 Supporting nature literacy includes building students' confidence

An important part of nature literacy is having the confidence to explore nature without fear, and the teacher's role is to allay these fears by discussing possible dangers they might encounter. For example, in our part of England, possible hazards are ticks, adders and stinging nettles. The teachers explain to students that most tick bites are harmless but it is important to remove a tick as soon as possible (see *ASE Topics in Safety: Topic 14 Living organisms* for more information: www.ase.org.uk/resources/topics-in-safety). Adders are more afraid of us than we are of them, and they generally keep out of our way; most snake bites are not serious, but if bitten, we should get checked out at hospital just in case. The last death from an adder bite in Britain was in 1975. Nettle stings are generally harmless, and only in rare cases do people have an allergic reaction. One way of helping to allay fears about nettles is to explain to students that the stinging hairs are only on the stems and lower surfaces of the leaves, so the tops of the leaves are safe to touch.



- Relate information about the site to the students' own experiences. For example, encourage them to find some of the same plants and animals in their own gardens or on the way to school.
- Use a questioning approach. So rather than always giving direct information, ask questions such as 'Do you know how...?', 'What do you think...?', etc.
- Encourage students to be generally curious and adopt a detective-like approach (e.g. working out which animal left those tracks and which way it was going).
- Encourage students to ask authentic questions, which they want to solve, and provide the time and 'freedom' for them to explore the site to search for the answers. Some questions might be unanswerable but would involve consideration of both scientific information and human values (e.g. 'Is it better to grow trees here for timber or to protect the biodiversity?', 'How can we stop deer destroying the young plants?', 'What effect might dog walking have on the biodiversity?').
- Encourage students to use all their senses, not just their sight, to enjoy and learn more about nature. This can also trigger an emotional connection with nature. As science teachers, we often overlook the value of hearing, touch and smell while exploring nature.
- Debrief the students after the fieldwork, giving them an opportunity to reflect on their experience together.
- Organise some follow-up action for the students, such as projects, presentations, campaigns, guides to the site, self-guided walks, identifying biodiversity 'hotspots' on the site, holding a debate or writing a pledge to take action (e.g. to learn the names of flowers or to attract more bees into their garden).

Professional development of teachers is very important here too. From our experience in initial teacher education and delivering professional development within schools, it is clear to us that when teachers undergo training that introduces them to inspiring contexts and activities that spark their own interest

in a topic, this in turn also enhances enthusiasm and engagement among their students. Note that, as set out in the ASE's *Best Practice Guidance on Outdoor Learning* (ASE, 2020), 'best practice should seek to include... appropriate consideration for health and safety, but this should not be used to prohibit regular use of the outdoor learning environment.' Accordingly, all activities must be fully risk-assessed using guidance from appropriate organisations such as Chapter 6 and 9 of the ASE's publication *Be Safe!*, appropriate CLEAPSS guidance (www.cleapss.org.uk), the Design and Technology Association (www.data.org.uk), schools and other relevant organisations.

Conclusions

Nature literacy fosters effective participation and empowers young people to engage with the natural world. A nature-literate person has the knowledge, skills and confidence to actively engage with nature conservation. An Ipsos MORI survey of the British public commissioned by the RSPB reported 92% of people agreeing that it is important for children to have outdoor experiences connected to nature, such as feeding birds, climbing trees or looking at insects, and 82% agreed that 'schools should play a role in ensuring all children have these types of experiences' (RSPB, 2010). This strongly suggests that the public are expecting schools to shoulder the responsibility for engaging children with nature. We know that some secondary schools are delivering excellent opportunities for their students in this regard, but we are also aware from our frequent visits to numerous schools that this is a small minority, and the range of provision is vast.

Schools face many constraints to developing nature literacy among their students, but we believe many of these can be overcome with due consideration. From a curriculum development perspective, a key to incorporating our suggested pedagogical approach is not to see it as another addition to an already overflowing curriculum, but to integrate it into schemes of work and use it as an opportunity to satisfy both the content and values requirements of the curriculum.

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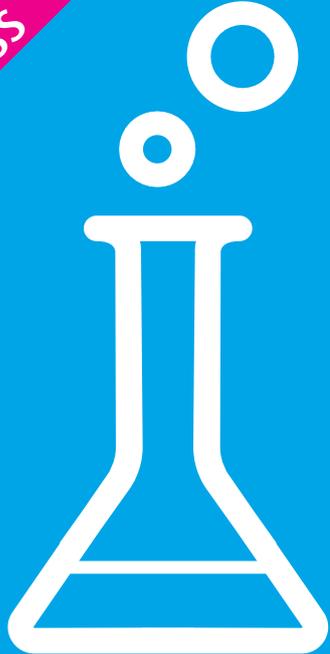
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