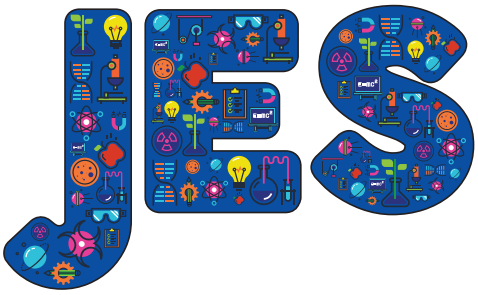
Embedding sustainability in primary science education



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Abstract

As a provider of primary science CPD and lecturer in primary science Initial Teacher Education (ITE), I consider how a primary science curriculum can provide an opportunity to embed climate change and sustainability education. Using a global learning approach and the UN Sustainable Development Goals, this article suggests that science education is central to the preparation and empowerment of young people to help reduce climate change and manage its consequences. Based upon my experience working with primary schools and my research in this area, I offer an approach to incorporating education on climate change and sustainability.

Keywords: Sustainability, disciplinary knowledge, substantive knowledge, purpose, global citizenship

A high quality science education fit for our future global citizens

'We are facing a global crisis in which the natural systems on which we depend are on the verge of breakdown' (Dasgupta, 2021:1). In agreement with the Sustainability and Climate Change Strategy for Education (DfE, 2022), educators have both the responsibility for and privilege of educating and preparing young people for a changing world, ensuring that they are equipped with the right knowledge, understanding and skills to meet the challenges they will face. UNESCO (2021) highlights the importance of rethinking education, emphasising the importance of education as the foundation for sustainable development. In this article, I argue that primary science education provides *'the foundation for understanding the world'* (DfE, 2013) and, as such, it is central to the development of such knowledge, understanding and skills.

In England, an Ofsted Research Review for Science published in April 2021 highlights factors that could contribute to 'high quality' science education, based on a wide range of research evidence (Ofsted, 2021). Whilst this Ofsted review is not phase-specific, Turner *et al* (2022) have developed a useful guidance document for primary schools, considering how the review relates to primary science practice. Whilst a renewed urgency to reconsider the important role of science education in sustainable development is paramount, drawing on this guidance can be considered in parallel.

The weakened status of primary science education as a core subject in England due to the focus on high-stakes accountability testing in English and maths motivated my research to explore how a global learning pedagogical approach to science could reignite its core status (Strachan, 2020). My mixed-methods research design collected quantitative data to measure stakeholder (senior leaders, leaders of science, teachers, advisers and pre-service teachers) attitudes towards global learning in primary science, whilst qualitative data, in the form of semi-structured interviews and case studies, explored how professional development could support the implementation of the approach. (This perspective article focuses on describing the approach, rather than presenting the data.)

The research described above highlighted that high quality science can be supported by sustainability education, giving it purpose and relevance. However, as Walsh (2021) suggests, the majority of teachers feel under-prepared for the task of putting climate change and sustainability at the heart of their teaching. I will therefore outline, from a practitioner's perspective, how we can embed sustainability in the primary science curriculum in a manageable way, contributing to a high quality science education fit for our future global citizens.

Figure 1. Key definitions.

Global Learning: 'A pedagogical approach that puts (science) learning in a global context, fostering critical and creative thinking, self-awareness and open-mindedness towards difference, understanding of global issues and action and optimism for a better world' (Bourn, 2016).

Sustainable Development Goals (SDGs): 'A collection of 17 interlinked global goals designed to be a blueprint to achieve a better and more sustainable future for all' (UN, 2015).

Five emerging issues for primary science teachers

Turner *et al* (2022) have helpfully identified five key issues from the Ofsted Research Review that are particularly relevant to primary science. These were: the importance of subject leadership and teacher expertise in science; the need to develop both children's substantive and disciplinary knowledge; carefully sequenced science learning to ensure that ideas are learned and applied; a purposeful selection of teaching approaches; and ensuring that teachers have sufficient subject knowledge to assess effectively. These five key issues will be used to frame my research-informed recommendations on how global learning and the Sustainable Development Goals (SDG) (Figure 1) can add purpose and value to primary science education.

1. Subject leadership and developing teacher expertise in science

Research findings from primary schools that trialled a global learning approach to primary science revealed that having a shared understanding of the value and purpose of the science ensured that it was given the '*planning time, recognition and support'* it deserves (Strachan, 2021). These findings are supported by the Primary Science Quality Mark (PSQM, 2020), who identified that having a clear vision and 'principles' for science learning enables the school's leadership to monitor, support and improve teaching, learning and assessment in relation to these principles.

The science vision and principles from one such primary school (Figure 2) is underpinned by the wider school ethos of ensuring that all members of the school community are respectful, resilient and responsible global citizens. This includes the importance of equipping children with the knowledge and skills to solve problems with innovative solutions. For this school, supporting teachers to give real purpose to their science teaching has become a key area of development. This has included professional development on the integration of the SDGs in relation to each science programme of study.

2. Substantive and disciplinary knowledge

Considering global learning in relation to primary science education is based on the premise that enabling children to be global citizens of the future,

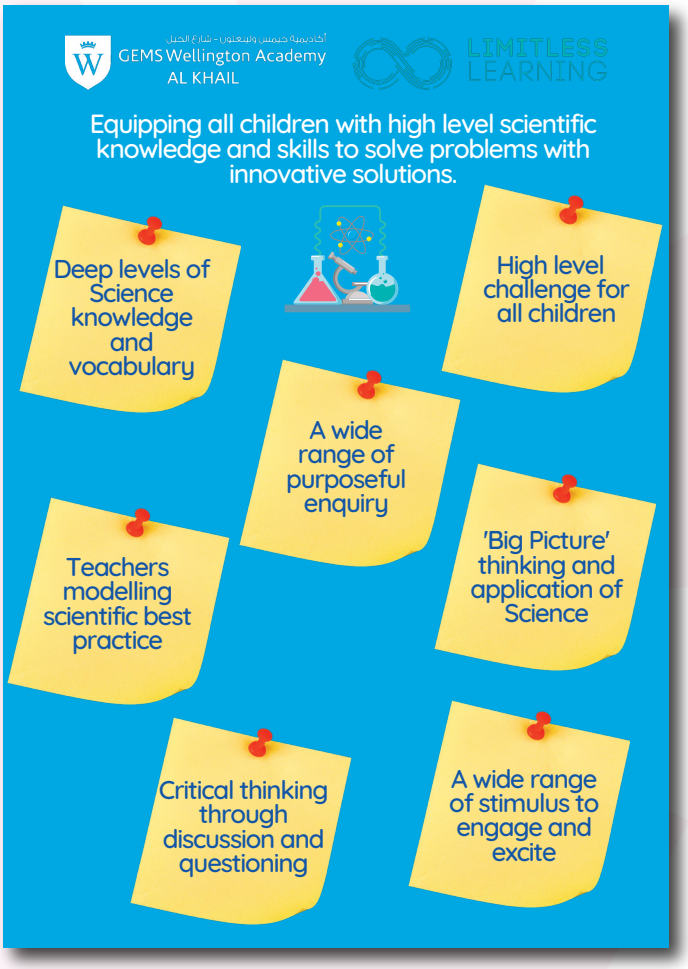
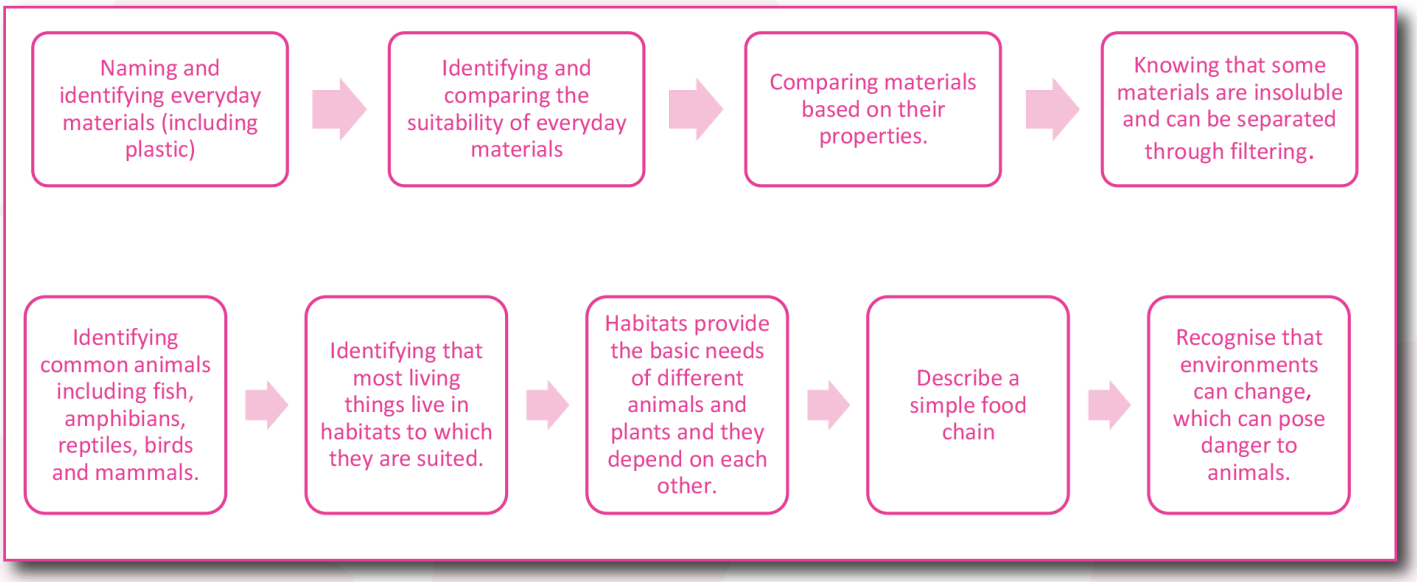


Figure 2. An example of a primary school's science vision and principles.

Figure 3. A progression of science concepts informing an understanding of the negative impact of micro-plastics on ocean biodiversity.



empowered to make responsible decisions and actions, requires a secure foundation of substantive knowledge (science content) as well as disciplinary knowledge (working scientifically). For example, we cannot expect children to make informed decisions about avoiding the use of plastic-based glitter so that it does not impact on ocean biodiversity, unless they have a secure foundational knowledge in relation to both materials and animals in their habitats developed across the years of their science curriculum (DfE, 2013). An example of such a progression can be seen in Figure 3.

Only with secure foundational knowledge can children begin to care about the effect of glitter going down the sink and how this might enter the food chain of ocean organisms. Schools who trialled the global learning approach were able to link science learning to real issues, global contexts and purposeful enquiries, ensuring that children were able to draw upon their prior knowledge of key concepts when considering responsible action, innovation and solutions. Findings showed that security of foundation knowledge in science enabled children to consider the consequences of their actions, e.g. the link between glitter in the oceans and animal survival.

Equally, empowering children to be agents of change (Bourn, 2021) enables them to develop an understanding of how to answer problems that can be solved using a range of enquiry approaches and through secure development of working scientifically skills. For example, 'how can we prevent plastic-based glitter and other micro-plastics entering ocean food chains?' can be supported through a range of enquiry approaches such as:

- **Grouping and classifying**: Which glitters/packaging are soluble and which are insoluble?
- **Comparative testing**: Will the type of material used as a sieve affect how much glitter is separated?
- **Secondary research**: Which alternative materials make the best plastic-free shiny glitter?

The Ofsted Review (2021) asserts that, when young people develop their disciplinary knowledge, they learn about the diverse ways that science generates and grows the knowledge through scientific enquiry. This can inform decisions (such as the choice to avoid using plastic-based glitter) as well as innovative action (such as the development of plant-based glitter or effective filtration inventions). Using purposeful science enquiries based on real-life issues meant that children were more engaged and findings were more meaningful (Strachan, 2020).

3. Curriculum-led and sequenced learning

Embedding global issues into science learning can provide context and purpose (Strachan, 2020); however, it is important that the core science knowledge and skills are not lost, something that

Figure 4. SDG 3 Good Health and Wellbeing Goal in context, from *Saving The Planet One Science Lesson At A Time* (Strachan & Davey, 2022).

can be an issue with theme-based learning (Barnes, 2015). Turner *et al* (2022) argue that developing a curriculum that is meaningful does not mean replanning the whole curriculum, but focuses on both 'what' is taught as well as 'how' it is taught, ensuring that key ideas are understood and applied.

As a result of my research conducted with case study schools, I offer a framework sharing 'how' SDGs can provide a context and purpose for science learning, as part of a sequenced, cohesive curriculum. An example of this is shown in Figure 4, where a learning experience draws on the 'good health and wellbeing' Sustainable Development Goal Three (SDG 3), to show the SDG in context (Strachan & Davey, 2022).

Strachan (2020), along with Nag Chowdhuri, King and Archer (2021), support the importance of providing relatable contexts for learning that link science learning to children's own interests and concerns. As Figure 5 demonstrates, the framework shows how the SDG can support children to develop a deeper understanding of core knowledge through connecting, critical thinking, purposeful enquiry and application.

As part of the continuity between and within topics in this example, children build on their knowledge of animals, including humans, from previous topics, such as their knowledge related to the human circulatory system in relation to SDG 3.

CORE (Planned curriculum knowledge and skill objectives)	- Recognise the impact of exercise and lifestyle on the way our bodies function. - Planning different types of enquiries to answer scientific questions. - Recording results with increasing complexity (taking repeats)
CONNECT (Explore different perspectives, different examples and ideas around the world)	Develop science capital by exploring sports and exercises practised by families and friends around the world. Exploring global issues: Why do some children not get enough exercise?
CRITICAL THINKING (Activities designed to elicit prior knowledge, retrieve and consider different ideas)	Which sport is best for our health? This is helping to develop children's argumentation skills.
CURIOUS (Purposeful enquiry drawing on planned development of working scientifically skills)	Comparative testing: Which exercises can increase our heart rate the most?
CREATE (Application of knowledge to responsible actions and problem-solving)	Design a new health game that can be accessed by all (applying findings from purposeful enquiry and developing understanding of the benefits of exercise on our heart, lungs and muscles).

Figure 5. Framework with SDG 3 example.

Figure 6. A global learning approach to 'Uses of Materials'.

Critical thinking: *'Do we need to wrap presents?'*
As highlighted in *Saving The Planet One Science Lesson At A Time* (Strachan & Davey, 2022), a vital component of being a global citizen is the development of critical thinking and questioning our own understanding and assumptions. Within science learning, offering opportunities for children to reflect on their own perspectives and recognise the possibility of multiple viewpoints will not only support a better understanding of the nature of science, but will also enable teachers to consider prior learning and experiences on which disciplinary and substantive knowledge can be developed further. The question above, for example, can help children to think about the materials that we use to wrap presents, where those materials come from, their properties, and how we could conduct enquiries to find more suitable, sustainable materials.

Creative thinking: *'How can we wrap presents without using plastic sticky tape and newly made paper?'*
Whether children have developed their knowledge and skills through direct teaching or enquiry-based learning, having the opportunity to apply these within problem-solving contexts not only allows teachers to assess understanding of knowledge and skills, but also empowers children to see how their science learning has purpose in relation to everyday decisions and global issues.

Connecting ideas: *'How do you wrap presents for celebrations in your community?'*
In relation to the Primary Science Capital Approach (Nag Chowdhuri *et al,* 2021), making sure that, as teachers, we start with the child, their backgrounds and experiences ensures that they see the relevance of science learning to their local and global perspectives.

Outdoor learning: *'Let's look at the trees that our wrapping paper comes from.'*
As recommended in the Dasgupta review (2021), enabling people to understand and connect with nature will empower them to make informed choices and demand the change that is needed.

4. Purposeful selection of a range of teaching approaches

Teaching approaches such as direct instruction and purposeful enquiry-based teaching can support knowledge and skills to be effectively developed. Alongside this, an approach to science learning that promotes an understanding of global issues and action and optimism for a better world, a range of critical and creative pedagogical approaches should be interwoven into science topics. Hoath (2020) and Willingham (2020) both encourage the promotion of opportunities for children to develop critical thinking skills, allowing them to draw on substantive knowledge to solve problems and raise new questions and discoveries. Figure 6 provides a suggestion for how a topic on 'materials' might use a global learning approach, incorporating different teaching approaches.

5. Teachers' knowledge and assessment

One of the key findings of my research with teachers, which involved supporting them to plan their science programmes of study using a global learning pedagogical approach, was their lack of confidence when making links between global issues and science programmes of study. Supporting teachers to consider how they would assess science knowledge and skills within a global learning approach is important. This requires teachers to have secure science subject knowledge as well as an understanding of global issues.
A global learning approach to primary science education (Strachan & Davey, 2022) suggests that science learning experiences could include four learning outcomes:

- *A knowledge outcome*: I can identify suitable properties for a wrapping material.
- *A skill-based outcome*: I can plan an enquiry to find out which material is the strongest.

- *An attitude-based outcome*: I can choose a material that has less impact on the environment.
- *A reflection*: One way I think differently about present wrapping than I did before is…

Final thoughts

Both the research outlined in this article and my work as a lecturer and teacher educator of primary science have highlighted that, as a discipline, science has the potential to be central to the development of global citizens and their sustainable future. Teachers need leadership support and time to explore different ways of working and to bring real meaning to the curriculum that they deliver. A supportive community of practice can enable us to enrich science learning through sharing resources and activities that are both relatable and relevant. Using the UN Sustainable Development Goals gives us an opportunity to develop young people's scientific literacy, supporting children to use knowledge about the natural world and knowledge about science (OECD, 2013) when faced with real-life decisions and actions. We have the opportunity to support teachers as agents of change, developing a 'high quality' primary science education that can support children in an unpredictable world.

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