

Barriers to Learning for Sustainability: Reflections from a British Science Teacher

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Short report

Keywords: learning, sustainability, geoscience, curriculum, school clubs

Posted Date: March 4th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-266453/v1>

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Version of Record: A version of this preprint was published at Sustainable Earth Reviews on January 30th, 2023. See the published version at <https://doi.org/10.1186/s42055-022-00050-3>.

Abstract

We collectively face a constellation of complex and interconnected environmental, social, and economic problems that threaten human and planetary wellbeing now and in the future. Learning that enables students across all levels and settings of education to become change agents for a more sustainable future, is widely expected to play a crucial role. However, “education as usual” with its one-way transmission of information from teacher to passive learners, disciplinary silos, and high-stakes, facts-based assessments, will not suffice to equip learners with the knowledge and competencies needed to address chronic and complex obstacles to sustainability. Forging a more sustainable path forward will require rethinking of traditional educational systems that were designed for different times. It will also necessitate a shift from traditional, teacher-centered pedagogies to strategies that nurture action-oriented, experiential and reflective learning in the face of complexity, uncertainty, and rapid change.

In this contribution, the reflections of a British science teacher provide a first-hand perspective on the disconnect between the international discourse on transformative learning for sustainability and everyday classroom practice within the constraints of prevailing educational systems.

Introduction

Calls for more sustainable ways of living are gaining immediacy in the face of intertwined global challenges and extensive and accelerating evidence that humankind’s current trajectory is un-sustainable (e.g., [1, 2]). Complex global problems such as poverty, growing inequality, water scarcity, environmental degradation, species loss, and climate change threaten human and planetary wellbeing now and in the future [3, 4, 5]. “Embarking on the path of sustainable development will require a profound transformation of how we think and act” ([6], p. 7). This can only be accomplished through learning that fosters critical reflection upon the prevailing worldviews and systems that promote unsustainable ways of living and inspires and enables action for change [7, 8, 9, 6].

Education has long played a role in the global development agenda and has been said to lie at the heart of the Sustainable Development Goals (SDGs), an ambitious “blueprint to achieve a better and more sustainable future for all” [10, 5]. However, addressing complex and multifaceted challenges to sustainability demands innovative thinking regarding the nature and purpose of education and learning. “Education as usual”, which has been criticized for preparing students for life and work in service of consumption and national economies, will not be adequate for the task [9, 11]. As noted by Stefania Giannini, Assistant Director-General for Education for the *United Nations Educational, Scientific and Cultural Organization*, “We are increasingly asking if what people learn is truly relevant to their lives, if what they learn helps to ensure the survival of our planet” [12].

In this paper, the reflections of a secondary British science teacher provide a first-hand perspective on how the lived practice of teachers compares to international policies for sustainability education and

illustrates systemic obstacles to providing both teachers and students with the kind of learning experiences they need to lead for change towards a more sustainable future.

Background

A survey of the literature reveals a wide array of names for sustainability-related education, including Education for Sustainability, Education for Sustainable Development, and Environmental and Sustainability Education (e.g., [13, 14]). These and other terms are often used interchangeably, although they may be interpreted differently. Although the desired content and methods of sustainability education are debated, many agree that effective education for sustainability employs interdisciplinary, whole-system approaches to learning that integrate curriculum content and organization with school ethos and management, facilities and resource use, and community partnerships (e.g., [15, 16]). Education for sustainability provides learners, both teachers and students, with “an inspiring mission – to participate in creating a sustainable future” ([16], p. 43).

Education for Sustainable Development (ESD) is described as “holistic and transformational education” which addresses learning content and outcomes, pedagogy, and the learning environment [17]. ESD is the most widely-used phrase in the international discourse about education, learning, and sustainability and is a key component of the Sustainable Development Goals [13, 18]. ESD calls not only for integration of key topics such as climate change, disaster risk reduction, and sustainable consumption into the curriculum but also for a shift in the teacher’s role from purveyor of knowledge to facilitator of learning that helps students develop key sustainability competencies (Fig. 1). These competencies represent “the attributes individuals need for action and self-organization in various complex contexts and situations” and develop from an “interplay of knowledge, capacities and skills, motives and affective dispositions” as the result of experience, action, and reflection ([6], p. 10).

Rieckmann [6] highlighted three key pedagogies for ESD that draw on ideas developed by [19] and references therein, [20], and others and support learners in developing sustainability competencies (Table 1).

Table 1
Key pedagogies for implementing ESD.

Modified from ([6], p. 55).

Pedagogy	Description
1. A learner-centered approach	emphasizes the active development of knowledge through learning experiences that require learners to reflect on their own knowledge and learning processes.
2. Action-oriented learning	draws on Kolb's experiential learning cycle with the following stages: 1. Having a concrete experience, 2. observing and reflecting, 3. forming abstract concepts for generalization, and 4. applying them in new situations [20].
3. Transformative learning	learning that empowers learners to question and change the ways they see and think about the world in order to deepen their understanding of it [21, 19].

How does ESD's vision of experiential, reflective learning that can transform both individuals and society fit into the constraints faced by classroom teachers who work within current educational systems? The following personal reflections from first author Sally Parry, a science teacher with a geoscience background who teaches at a girls' comprehensive school in the outer suburbs of London, provide insights into both an educator's lived practices and students' perspectives about learning for sustainability. These contemplative observations: 1) serve as a launch point for consideration of findings from the literature relevant to learning for sustainability and 2) furnish an opportunity to consider gaps between international policy documents aimed at reorienting education to foster learning for sustainability and the everyday realities of teaching within the limitations of current education systems.

A view from the classroom: reflections of a British science teacher

I have been thinking about sustainability, what it means to students, and whether we are adequately equipping our young people with the information and skills they need to understand the underlying causes of challenges to sustainability and take action to affect meaningful change towards more sustainable ways of living. This is not a research study, but rather thoughts and observations from my daily life in the classroom in which I consider:

- the place of sustainability in the British National Curriculum
- what is being taught about sustainability, how it is being taught, and how student learning for sustainability could be strengthened
- what the students appear to think about sustainability issues and how this compares to my own ideas and preconceptions
- how the school and the government could capitalise on students' motivation to help shape more sustainable societies.

My school, located in the outer suburbs of London, is a larger-than-average comprehensive school for girls with 1,500 students. It is located in an affluent area and the proportion of pupils supported by extra funding for disadvantaged students or who have special educational needs and/or disabilities is much lower than the national average. During its last Ofsted (Office for Standards in Education, Children's Services and Skills) inspection in 2017, the school was rated as "outstanding" in all areas. Academically, it is a high achieving school and the Progress 8 score (the chief measure of school performance in the United Kingdom) in 2019 was "well above average".

In 2012 The Department of Education published guidance on the place of sustainability in United Kingdom schools. According to "Top Tips for Sustainability in Schools" ([22], p. 1) "Sustainable development means meeting the needs of all people now – including protecting the natural habitats that are essential to our survival – without compromising the ability of future generations to meet their own needs." How are teachers meant to educate about sustainability? Well, "teachers help drive and embed behaviour change through integrating learning about this area into teaching, both at a theoretical and practical level. They can also be role models in changing behaviour, for example, by cycling or walking to school" ([22], p. 4). That is good, as I walk to school and all my pens are stored in old biscuit tins, but not all my colleagues are in a position to walk or use public transport. What about helping students understand the fundamental science behind such pressing issues as resource management and climate change? Will a better understanding of the relevant science enable and motivate students to make more sustainable choices and lead by example?

Barriers to learning for sustainability - the curriculum

The assumption amongst many of my non-science based colleagues is that the curriculum covers everything that the students need to know about sustainability. This is not unjustified as the textbooks used follow the national curriculum, but they are also very restrictive in how the content is delivered. Learning objectives are often narrow and factual content is prioritised over the mastery of competencies that enable students to engage in collaborative problem-solving around challenges to sustainability.

In England the National Curriculum [23] includes sustainability topics within science and geography. The following are to be covered within the science curriculum at KS3 (Key Stage 3; ages 11–14) [24]:

- Earth as a source of limited resources and the efficacy of recycling
- the carbon cycle
- the composition of the atmosphere
- the production of carbon dioxide by human activity and the impact on climate.

At KS4 (Key Stage 4; ages 14–16) sustainability-related content in science is expanded to include [24]:

- evidence for anthropogenic causes of climate change
- the potential effects of increased levels of carbon dioxide and methane on the Earth's climate

- common atmospheric pollutants
- the Earth's water resources and obtaining potable water
- life cycle assessments and the viability of recycling.

In the KS3 geography curriculum [25] students are meant to understand:

- how human and physical processes interact to influence and change landscapes
- environments and the climate
- how human activity relies on effective functioning of natural systems
- change in climate from the Ice Age to present
- geological timescales.

Geography is not compulsory at KS4.

As a result of this structure, the core content on sustainability is spread over more than one school department, with a disconnect between teaching the science behind sustainability challenges such as climate change and consideration of the consequences and effects within the geography department.

For me, the basis of all sustainability education lies in understanding the geoscience behind the resources we remove from the ground as well as considering how our electricity is generated. Crude oil extracted from under the sea must seem a long way removed from the average teenager's life in the suburbs. It has led me to ponder on how much students know about where the things they use come from. Do the students realise that their phones are ultimately unsustainable? At the current rate of extraction, reserves of indium (used in touchscreens) will be exhausted in ten years [26]. These thoughts have led me to re-consider my teaching approach in the science classroom. "Too easily, we can become obsessed with the detail of individual lessons when in fact, they are only part of a greater whole" ([27], p. 5). I have become more aware of the importance of putting the topic I am teaching into an authentic context that connects to my students' world. This is consistent with recommendations of researchers in sustainability education who emphasize the value of situating learning in real-world contexts that allow students to link their learning to issues that matter them, their families, and their community [28, 29, 30].

Teaching some basic geoscience, such as the age of the Earth, the formation of the solar system, main evolutionary dates and previous mass extinctions could, in my opinion, help to put current rates of greenhouse gas emissions and species loss into context for students. This is important because key Earth science topics (climate change, mineral and water resources, natural hazards) and skills (e.g.. an understanding of geological time; the ability to work across different temporal and spatial scales; interdisciplinary and systems thinking) connect to the environmental and socio-economic dimensions of sustainability [31, 32]. However, Earth science is not well represented in our National Curriculum and is either absent or of poor quality in many of the world's schools [31, 32]. Learning key geoscience concepts is essential to a holistic understanding of sustainability, but is it enough?

Barriers to learning for sustainability - the education system

A fragmented curriculum is not the only barrier to learning for sustainability; the wider issues of school finances and high-stakes assessments must also be considered. I had the opportunity to speak to a member of the senior leadership team, who told me that the sustainability-related issues within the school have been discussed at the most senior level. It has been relatively simple to implement some basic policies such as having recycling bins in every classroom and reminding staff to make a conscious effort to turn off lights and projectors. Recycling bins have also been placed in the canteen. The school-wide policy of covering books in sticky-backed plastic was also dropped this year over concerns of generating more plastic waste. All this aligns with Department of Education's guidance of staff modelling good behaviour that promotes sustainability [22]. In addition, a senior member of staff worked with a core group of year 11s (age 15 to 16) to talk over their plans for a sustainability club and help them to get the club up and running.

However, tackling issues such as using plastic cutlery in the canteen (a problem highlighted by the students) is not always straightforward. The canteen has already seen an increase in costs due to the new supplier this year and bringing in biodegradable wooden forks would only increase costs further as they are more expensive than plastic. The use of metal cutlery is equally problematic in that the canteen cannot accommodate all the students who wish to eat there and so they take their food away. The logistics of getting the forks back into the canteen for washing up, particularly during the short break time, is unworkable. In the past, students were leaving metal cutlery on the field, creating many more problems. As with many schools, the buildings date back to 1926 and were not designed for the current number of students. From general conversations with the maintenance team even the newer buildings are not nearly as energy-efficient as they were designed to be. An issue of some kind exists with every building on site with little money to rectify the faults.

This relates to the larger issue of limited school funding and its perceived impact on the ability to promote sustainability-related instruction, facilities, and practices. How do you reconcile spending more money on addressing sustainability when the school's budget is so tight that doing so would directly affect day-to-day school operations and, ultimately, the students' learning? Should the school be put in the position of having to make such a decision? As a senior leader commented "What are we meant to say to the students? We can be more sustainable, but you'll probably get one grade lower in your GCSEs (General Certificates of Secondary Education). What do you choose?" This is clearly a false choice, however, as numerous studies have shown that education for sustainability enhances student achievement (e.g., [16] and references therein). This is discussed further below.

My observations and experiences as a teacher, as recorded in the reflections above, are consistent with findings from secondary schools around the world. Taylor et al. (2019) [33] noted that implementing sustainability education in secondary schools presents some unique opportunities and challenges. Secondary students are nearing voting age, affording an opportunity to link their learning to "informed and active participation in democratic processes such as voting, choices, civic and community engagement" ([33], p. 104). However, several obstacles exist to implementing holistic, interdisciplinary education for sustainability at the secondary level [34, 35, 33]:

- The secondary curriculum is commonly partitioned into “disciplinary silos”, making cross-disciplinary collaboration and lesson planning difficult
- Sustainability-related instruction is commonly perceived as an “add-on” that must compete for time within an already crowded curriculum
- High-stakes testing narrows the curriculum and promotes “teaching to the test”
- Few teachers have training in the content and pedagogy of Education for Sustainable Development/Education for Sustainability.

Additional, widely-reported roadblocks to systemic implementation of teaching and learning for sustainability include lack of funding, limited access to effective instructional materials, and school staff members’ resistance to adoption of whole-school approaches to sustainability education (e.g., [15, 35]).

The perception that integrating sustainability education into the curriculum will negatively impact student performance is widespread at my school in the midst of a global testing culture and its “focus on standardization and high-stakes testing” and resulting “narrow view of what counts as teaching and learning” ([36], p. 192). However, a synthesis of the results of studies from 18 countries to investigate the role of ESD in quality education [30] “showed evidence that ESD improves test scores and helps achieve other desired outcomes, such as improved student attendance and problem-solving skills” ([30], p. 233). Although no countries claimed evidence for a cause and effect relationship between ESD and improved test scores, eight countries “reported increased academic performance in ESD schools” ([30], p. 233), with no reports of negative impacts of ESD on student performance. My teacher colleagues and senior leaders in my school have not been exposed to this data.

Student perspectives - the sustainability club

Several students recently approached the head teacher to set up a sustainability club. This is something that the school is extremely willing to support. The Department of Education states that “being a sustainable school raises standards and enhances young people’s well-being. Research supports the idea that this is because sustainable schools engage young people in their learning, thereby improving motivation and behaviour, and promote healthy school environments and lifestyles” ([22], p. 1).

It is easy to make assumptions about what the students need to know and understand to help them make informed decisions about sustainability-related issues. However, my preconceptions are based on my education to postgraduate level rather than on the interest and experiences of the students. Listening and talking to a range of students in the sustainability club and in my general science lessons was needed to give me insight into what we are doing well and what needs further development.

Knowing that I have an interest in resource management and sustainability, students from the sustainability club invited me to come along to their lunchtime meetings and were kind enough to allow me to take notes of our conversations. I used the opportunity to chat with them about their views on sustainability and what they wanted to achieve. All names have been changed when quoting their views. The ages of quoted students are given in parentheses.

Firstly, the students from the sustainability club told me how important the issue of climate change is to them. Jess (14): "It is very important; most adults don't realise how important it is. They don't understand the effects." Beth (14) added that "No teachers care, it is not a pressing issue for them." So, in their eyes we are already failing them. This would suggest that the school curriculum is not helping students learn about climate change and other challenges to sustainability, especially if they don't believe their teachers have any engagement in the subject. The students must be learning about climate change outside of the formal educational setting.

I spoke to members of the sustainability club to ask where they learn about sustainability-related issues. Amelia (15) remarked that "It is easy to find the information; I just need to watch a David Attenborough programme on TV." Megan (12) said that "I haven't learnt anything at school about climate change." This comment was followed by a description of the ozone problem and global warming which she claimed she had learned at school, but it is not in the curriculum. Even in year 13 (ages 17 to 18), most students cannot distinguish between the thinning of the ozone layer and greenhouse gas emissions leading to climate change.

Most students agreed that social media are their main source of information and, apart from Greta Thunberg's Instagram account, I could not elicit the exact sources. When questioned about the main news websites in the United Kingdom, no one said that they visited one on a regular basis.

One older student did mention an increase, over the past eighteen months, in the number of school assemblies that address unsustainable practices. These assemblies featured selected clips from the "Blue Planet" series [37]. Watching videos about plastic pollution clearly shocks the students into thinking about their own habits. However, when talking to the younger students before teaching the relevant section in the curriculum, none could state how plastic is produced, or name the raw material from which it is made. "What I really need to know is how harmful plastic actually is" (Ellie, 13). She was quite perplexed when I tried to explain that we do not yet fully understand its impact, suggesting that students are unaware of the complexity and uncertainty inherent in the many obstacles to sustainability.

These students are more knowledgeable than their peers in that they could easily list predicted consequences to the planet if no action is taken to address climate change and other pressing obstacles to sustainability. However, they find it difficult to describe how their knowledge could be applied to help mitigate these problems. This implies that the students have learned about unsustainability and its consequences, but are not being provided with learning opportunities that develop their ability to contribute to a more sustainable society. This suggests the importance of modifying the curriculum to include experiences that engage students in collaborative, project-based learning focused on problem-solving around sustainability issues that matter to them. I also gained the impression that, despite their keen interest in making more sustainable choices, students are reluctant to be seen as the first to make changes to their lifestyles.

The students from the sustainability club claim to be happy with the sources of their scientific information, but not with their learning in school as it relates to understanding unsustainable ways of

living and taking action to change them. A small group of younger students in the sustainability club declared that “people need to be taught about the power of consumption and the consequences of using resources.” Olivia (14) decided that “we need to teach people earlier and more (about) what’s happening.”

As noted earlier, sustainability concepts are currently scattered across different departments, with the majority residing in science. The students have expressed the opinion that sustainability-related learning would be far more effective if connected across the curriculum. The students told me that “We need to learn it in PSHE.” [38]. This suggests an awareness that addressing challenges to sustainability requires consideration of the social and economic dimensions of the problems as well as a scientific understanding. This is an ideal opportunity for the students to be involved in planning for curricular change to ensure that we address key topics and issues of importance to them. We could take the opportunity to pull together all the strands into a coherent set of lessons that cover the science, history, geography and politics. However, is a more cohesive, interdisciplinary approach to delivering content likely in itself to inspire change towards more sustainable choices? The literature clearly shows that acquiring more information does not guarantee behavioural change (e.g., [39] and references therein). To become agents of change for a better future, students must be given opportunities to engage in action-oriented, experiential learning and to apply their learning in real-world contexts.

The school’s sustainability club provides an excellent opportunity to engage students in problem-solving around unsustainable practices at their school such as the use of disposable plastic utensils and energy inefficiencies. We need to encourage the students to make changes themselves and to experiment with which solutions prove most effective. It was suggested to students in the sustainability club that they could lead by example. They were unhappy about using the disposable plastic cutlery in the canteen, but could they not bring their own and take it home to wash up? Where do their responsibilities lie?

The club members have proposed to hold a “sustainability week” at school next January and have decided to run a different activity on each day of the week, with specific tasks that are designed to help their fellow students consider the environmental impact of their choices. Examples include a plastic bag-free day with reference to countries such as Rwanda that already have a country-wide ban on plastic bags [40] and a mobile phone-free day with supporting calculations to show the accompanying reduction of its carbon footprint.

Finally, the students are aware of the need to look beyond their school to investigate the political and societal dimensions of barriers to sustainability. However, students are telling us that they don’t understand how the government works. Only five of my form of thirty 15-year-olds could name the local MP (Member of Parliament), despite his having held cabinet positions and being the subject of international news articles. I would hazard a guess that most adults could not explain how Parliament functions, either. This is something we should address, as a school, to prepare students to make informed decisions in the future and help them to develop a sense of responsible citizenship.

The students I spoke to voiced their frustration that, in their view, the older generations do not appear to care about or acknowledge their concerns. They want to be led by example and be given actual tasks to

do and guidelines to follow. Sarah (16) “Why can’t the government have an ad campaign on sustainability, with proper things to do; we never hear anything about it from them.” One comment from Abby (16) really caught my attention: “Sustainability is only for the elite – being vegan is for posh people. Privilege is being able to make choices”. These remarks suggest that students are not confident in their own abilities to effect change.

The students are very aware of how human activities are threatening Earth’s capacity to support people and other living things. Many are fully engaged with the issues around unsustainable ways of living and want to learn what can be done to mitigate the unfolding climate emergency and other urgent problems. Students seem to feel that the main barrier to a more sustainable future is that adults are not doing enough to address unsustainability and the school is not providing the information they need to take action and help promote more sustainable lifestyles.

Students’ dedication to the cause is another factor to consider. Even the most concerned are reluctant to make the changes that they know can make a difference. As a school we have to take some responsibility for the fear of being seen as a “geek”. However, the students need to “put their money where their mouth is” and take the first steps to adjusting their lifestyles. It may be wise to consider the dilemmas posed of “jumping on the bandwagon” of a cause without full understanding of the issue. When students who attended a climate march in London were asked about what they were protesting, they could not give details. As a school, we need to address the fact that we are not providing students with the information they require and the learning opportunities they need in a way that is accessible. Most are turning to social media as their main source of information, are unable to discern the scientific facts from the fiction, and are unsure about how to translate knowledge to meaningful action to counter climate change and other issues that will have profound impacts on their futures.

It must also be noted that not all students are interested in sustainability as a topic and have not been exposed to the concept of sustainability as an aspiration for a better future for humans and the planet. Making learning for sustainability a more integral part of the curriculum could help to engage more young people. The students’ suggestion of a sustainability-themed module that covers all the strands of science, politics, history and geography is a very good starting point for development of interdisciplinary learning experiences. However, the responsibility of writing the lessons and developing new, sustainability-focused curriculum should not lie with the schools and their already over-worked teachers. The national government, which develops the curriculum, needs to provide a clear policy and give guidance for how to systemically integrate cohesive, interdisciplinary education for sustainability. Of course, funding is a key issue, both for schools overall and in the form of dedicated amounts for each school to introduce a central sustainability policy. However, once implemented, education for sustainability should be no more expensive than education for unsustainability [41].

Rethinking teacher education to support to learning for sustainability

The need for a more cohesive approach to education for sustainability at all scales, ranging from individual lesson plans to school site operations such as food service and energy use, to national policies concerning curriculum and assessment, is a recurring theme of the reflections above. Research shows that student learning is transformed as much by student-centered Education for Sustainable Development pedagogies that “stimulate students to ask questions, analyse, think critically and make good decisions” as it is by sustainability content ([30], p. 231). Student-centered, collaborative learning experiences anchored in real issues help to cultivate sustainability competencies and develop students’ confidence in their abilities to take action and lead for change [6, 42].

However, translating the learned-centered pedagogies of Education for Sustainable Development to classroom practice asks a great deal of already overworked teachers, most of whom have not received preparation that addresses both the content knowledge and innovative teaching practices that comprise ESD [42, 43]. For teachers to serve as effective agents of change who can support student-centered, experiential learning, they “need the chance to develop the necessary competencies along their own educational pathway” ([44], p. 821). Meaningful change towards a more sustainable trajectory will require more than giving teachers and students opportunities to acquire factual information about sustainability. They must be given opportunities to construct and apply their own understandings of sustainability and engage in reflective and responsive teaching and learning that leads to transformative change.

Conclusions

Understanding systemic barriers to learning for sustainability is an important step in finding more effective ways to implement holistic approaches to sustainability education [35]. Learning that enables critical reflection upon current worldviews and systems that perpetuate unsustainability is essential to finding a more sustainable trajectory. However, as illustrated by the reflections above, traditional curricula, assessments, and teaching methods are ill-suited to the task of providing students with transformative learning experiences that support development of the knowledge, skills, and competencies needed to act as change makers.

For transformative change to take place, both teachers and students need opportunities to engage in interdisciplinary, solutions-oriented, participatory and collaborative learning experiences that foster new ways of thinking and inspire action that moves individuals and society away from unsustainable practices. This will require both the efforts of highly-motivated educators and a holistic, whole-system approach that integrates sustainability concepts and pedagogies into curriculum, assessments, school site operations, initial teacher preparation programs, and ongoing professional development for educators.

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

Not applicable

Competing interests

The authors declare that they have no competing interests.

Funding

Not applicable

Authors' contributions

SP collected, analyzed and interpreted the student and staff statements and wrote the paper. EM reviewed the statements and wrote the paper. All authors read and approved the final manuscript.

Acknowledgements

We are grateful to Sustainable Earth guest editorial board members David Crookall, Chris Skinner, and Jamie Cloud for their thoughtful comments, which helped to significantly improve this paper.

References

1. Díaz SM, Settele J, Brondízio E, Ngo H, Guèze M, Agard J, Arneth A, Balvanera P, Brauman K, Butchart S, Chan K. The global assessment report on biodiversity and ecosystem services: Summary for policy makers. Frisk E, Larson KL. Educating for sustainability: Competencies & practices for transformative action. *Journal of Sustainability Education*. 2019; 2(1): 1-20.
2. Messerli P, Murniningtyas E, Eloundou-Enyegue P, Foli EG, Furman E, Glassman A, Hernández Licona G, Kim EM, Lutz W, Moatti JP, Richardson K. *Global Sustainable Development Report 2019. The Future is Now: Science for Achieving Sustainable Development*. 2019.
<https://sustainabledevelopment.un.org/gsdr2019>. Accessed 20th March 2020.

3. Griggs D, Stafford-Smith M, Gaffney O, Rockström J, Öhman M, Shyamsundar P. Policy: sustainable development goals for people and planet. *Nature*. 2013; 495: 320-2.
4. Steffen W, Richardson K, Rockström J, Cornell SE, Fetzer I, Bennett EM, Biggs R, Carpenter SR, De Vries W, De Wit CA, Folke C. Planetary boundaries: Guiding human development on a changing planet. *Science*. 2015;347(6223):1259855.
5. United Nations. *Transforming Our World: The 2030 Agenda for Sustainable Development*. Geneva: United Nations; 2015.
6. Rieckmann, M. *Education for Sustainable Development Goals: Learning Objectives*. Paris: UNESCO; 2017.
7. Sipos Y, Battisti B, Grimm K. Achieving transformative sustainability learning: engaging head, hands and heart. *International Journal of Sustainability in Higher Education*. 2008; 9(1): 68-86.
8. Lotz-Sisitka H, Wals AE, Kronlid D, McGarry D. Transformative, transgressive social learning: Rethinking higher education pedagogy in times of systemic global dysfunction. *Current Opinion in Environmental Sustainability*. 2015; 16: 73-78.
9. Bell DV. Twenty-first century education: Transformative education for sustainability and responsible citizenship. *Journal of Teacher Education for Sustainability*. 2016;18(1):48-56.
10. *Education 2030: Incheon Declaration and Framework for Action—Towards inclusive and equitable quality education and lifelong learning for all*. Paris: UNESCO; 2015.
11. *Global education monitoring report, education for people and planet: creating sustainable futures for all*. Paris: UNESCO; 2016.
12. UNESCO Member States map the future of Education for Sustainable Development. 2018. <https://en.unesco.org/news/unesco-member-states-map-future-education-sustainable-development>. Accessed 20th March 2020.
13. Hopkins C, McKeown R. Education for sustainable development: an international perspective. *Education and sustainability: Responding to the global challenge*. 2002; 3 (2):13.
14. Summers D, Cutting R. *Education for sustainable development in further education*. London: Palgrave Macmillan; 2016.
15. Evans N, Whitehouse H, Gooch M. Barriers, successes and enabling practices of education for sustainability in far North Queensland schools: A case study. *The Journal of Environmental Education*. 2012;43(2): 121-138.
16. Cloud J., *Education for A Sustainable Future, Benchmarks: For Individual and Social Learning*. In: *Journal of Sustainability Education*. 2017.
17. *Roadmap for Implementing the Global Action Programme on Education for Sustainable Development*. 2014. <http://unesdoc.unesco.org/images/0023/002305/230514e.pdf>. Accessed 20th March 2020.
18. Agbedahin AV. Sustainable development, Education for Sustainable Development, and the 2030 Agenda for Sustainable Development: Emergence, efficacy, eminence, and future. *Sustainable*

- Development. 2019; 27(4):669-80.
19. Mezirow, J. Learning as Transformation: Critical Perspectives on a Theory in Progress. San Francisco: Jossey-Bass; 2000.
 20. Kolb, D.A. Experiential Learning: Experience as the Source of Learning and Development. New Jersey: Prentice-Hall; 1984.
 21. Slavich GM, Zimbardo PG. Transformational teaching: theoretical underpinnings. Basic principles, and core methods. Educational Psychology Review. 2012; 24(4): 569-608.
 22. Department of Education. Top tips for sustainability in schools. Department of Education. 2012. <https://www.gov.uk/government/publications/top-tips-for-sustainability-in-schools>. Accessed 20 Mar 2019
 23. Department of Education. National curriculum in England. Department of Education. 2019a. <https://www.gov.uk/government/collections/national-curriculum>. Accessed 20 Mar 2019,
 24. Department for Education. National curriculum in England: science programmes of study. Department for Education. 2019b. <https://www.gov.uk/government/publications/national-curriculum-in-england-science-programmes-of-study/national-curriculum-in-england-science-programmes-of-study>. Accessed 20 Aug 2019
 25. Department of Education. National curriculum in England: geography programmes of study. Department of Education. 2019c. <https://www.gov.uk/government/publications/national-curriculum-in-england-geography-programmes-of-study> Accessed 20th August
 26. Davies S, Mugglestone F, Richards R, Shelton T. OCR Geology for A Level & AS. Cheltenham: Illuminate; 2018.
 27. Allison S, Tharby A. Making Every Lesson Count: Six principles to support great teaching and learning. Carmarthen: Crown House Publishing; 2015.
 28. Brundiers K, Wiek A, Redman C. Real-world learning opportunities in sustainability: From classroom into the real world. International Journal of Sustainability in Higher Education. 2010; 11(4): 308-32.
 29. O'Donoghue R. Think piece: Re-thinking education for sustainable development as transgressive processes of educational engagement with human conduct, emerging matters of concern and the common good. Southern African Journal of Environmental Education. 2014; 30: 7-26.
 30. Laurie R, Nonoyama-Tarumi Y, Mckeown R, Hopkins C. Contributions of education for sustainable development (ESD) to quality education: A synthesis of research. Journal of Education for Sustainable development. 2016;10(2): 226-42.
 31. King C. Geoscience education: an overview. Studies in Science Education. 2008; 44(2):187-222.
 32. Stewart IS, Gill JC. Social geology—integrating sustainability concepts into Earth sciences. Proceedings of the Geologists' Association. 2017;128(2):165-72.
 33. Taylor N, Quinn F, Jenkins K, Miller-Brown H, Rizk N, Prodromou T, Serow P, Taylor S. Education for Sustainability in the Secondary Sector—A Review. Journal of Education for Sustainable Development. 2019;13(1):102-22.

34. Borg C, Gericke N, Höglund HO, Bergman E. The barriers encountered by teachers implementing education for sustainable development: discipline bound differences and teaching traditions. *Research in Science & Technological Education*. 2012; 30(2): 185-207.
35. Kang W. Perceived barriers to implementing education for sustainable development among Korean teachers. *Sustainability*. 2019;11(9):2532.
36. Kopnina H, Meijers F. Education for sustainable development (ESD). *International Journal of Sustainability in Higher Education*. 2014; 15:188-207.
37. BBC Earth. *Blue Planet: The Collection*. [DVD]. London: British Broadcasting Corporation; 2017.
38. Department for Education. Personal, social, health and economic education. Department of Education. 2020. <https://www.gov.uk/government/publications/personal-social-health-and-economic-education-pshe/personal-social-health-and-economic-pshe-education> Accessed 20th March 2020.
39. Frisk E, Larson KL. Educating for sustainability: Competencies & practices for transformative action. *Journal of Sustainability Education*. 2019; 2(1): 1-20.
40. de Freytas-Tamura K. Public Shaming and Even Prison for Plastic Bag Use in Rwanda. *New York Times*. 2017. <https://www.nytimes.com/2017/10/28/world/africa/rwanda-plastic-bags-banned.html>. Accessed 21 May 2020.
41. Cloud, J, *Teachable Moments/Let's Optimize Our Children's Capacity to Be Creative and Smart*. 2015. <https://cloudinstitute.org/blog/teachable-moments-lets-optimize-our-childrens-capacity-to-be.html>. Accessed 9 Feb 2021.
42. Rieckmann, M. Education for Sustainable Development in Teacher Education. An international Perspective. In: Lahiri, S. (ed.): *Environmental Education*, Delhi. 2019; 33-48.
43. Sinakou E, Boeve-de Pauw J, Van Petegem P. Exploring the concept of sustainable development within education for sustainable development: implications for ESD research and practice. *Environment, development and sustainability*. 2019; 21(1):1-10.
44. Bürgener L, Barth M. Sustainability competencies in teacher education: Making teacher education count in everyday school practice. *Journal of Cleaner Production*. 2018; 174: 821-6.

Figures

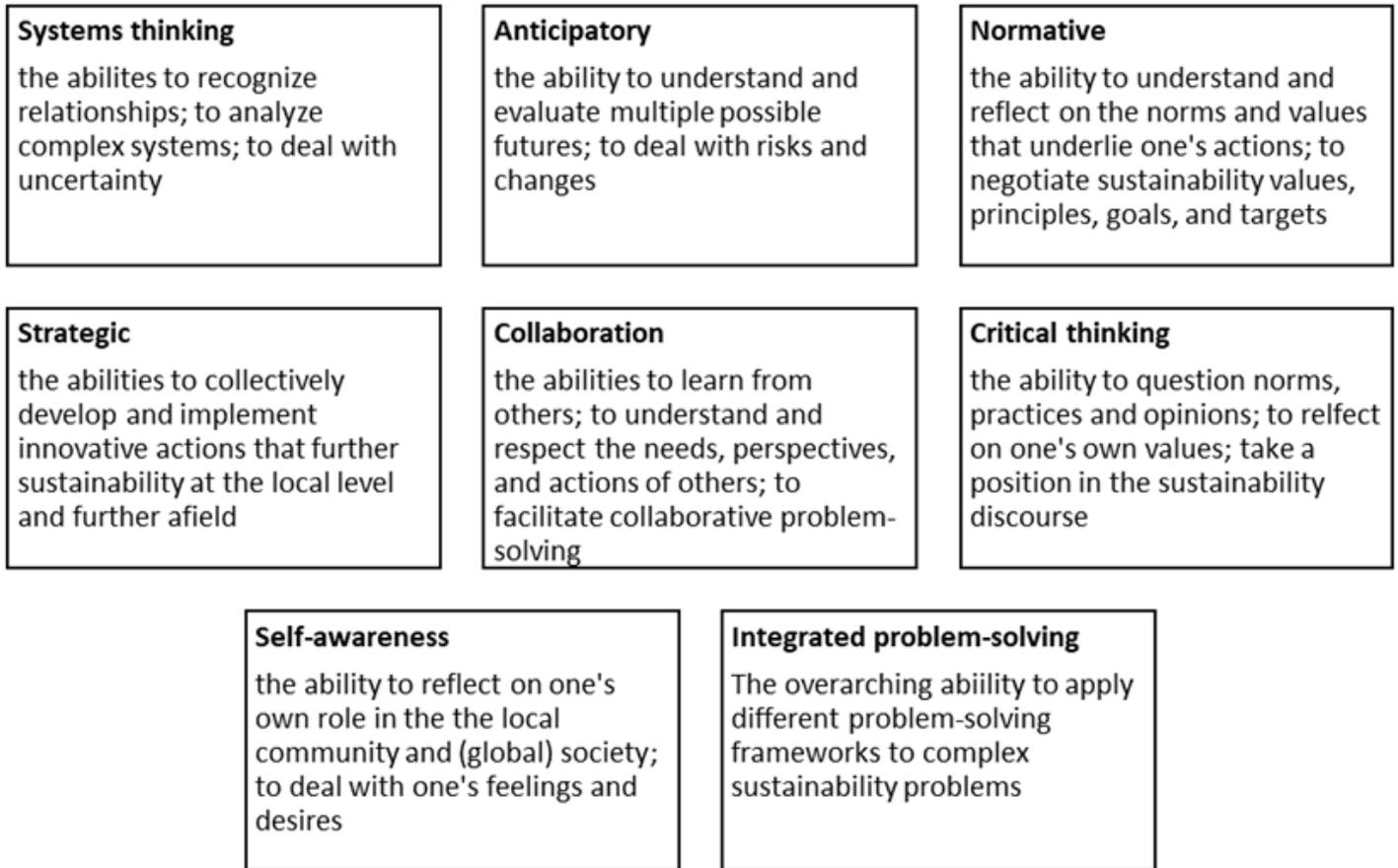


Figure 1

Key competencies for sustainability (abbreviated). Source: ([6], p. 10).