



Original research article

Beyond whole-school approaches to sustainability: Social practices and practice architectures at secondary schools in England

William Finnegan^{*}*Environmental Change Institute, University of Oxford, UK*

ARTICLE INFO

Keywords:

Schools

Education

Practice architectures

Sustainability

ABSTRACT

The education sector is an important component of the UK's net zero strategy, in terms of both the carbon footprint of school buildings and operations, and the opportunities to teach about environmental issues and empower climate action. However, school sustainability is often narrowly defined around individual choices and behaviours by different school stakeholders, rather than the broader patterns of social practices. This qualitative study of secondary schools in England involved stakeholder interviews and student focus groups at twelve schools in Greater London and the Thames Valley Region (Berkshire, Buckinghamshire, Oxfordshire) where 142 people participated in this research, including teachers, students, parents, governors and school staff (leadership, facilities, finance). School sustainability was explored through the lens of social practice theory, and three bundles of practices and arrangements were identified: teaching/learning, catering/eating, movement/travel. Whole-school approaches to sustainability were reframed through the semantic, material and social spaces identified in the theory of practice architectures. School sustainability requires a substantial investment into retrofitting school buildings, but it also needs to be woven in the culture of a school – firmly on the agenda of the governors and leadership team, parallel to an issue like safeguarding – and supported by clearly identified roles and relationships in each institution. This research is aimed at environmental educators and researchers wishing to apply insights from social theory to develop more effective whole-school approaches to sustainability. This research also reveals a potential divide between state and private schools when it comes to environmental education, empowerment and action.

1. Introduction

In April 2022, the UK Department for Education published a new sustainability and climate change strategy with the vision that the United Kingdom become 'the world-leading education sector in sustainability and climate change by 2030' [1]. This document outlined ambitious plans for climate education, decarbonisation of school buildings and operations, and the restoration of nature on the school estate. As a policy paper – as opposed to legislation – the strategy did not change the national curriculum or school funding in England (education is a devolved issue and controlled separately by the governments of Scotland, Wales and Northern Ireland) [2]. However, this potential roadmap raised the profile of school sustainability to the highest level since the 2006 National Framework for Sustainable Schools, which had set a goal for all schools to become sustainable schools by 2020, and was quietly shelved after the 2010 election [3].

School sustainability research emerged from the field of

environmental education, based on the recognition that the physical environment of education and the way in which schools operate can reinforce or contradict messages of sustainability in the classroom [4,5]. School energy consumption has also been explored through energy and emissions modelling and studies of feedback to building users [6–8]. While energy research has engaged with theories of social practice in recent years [9,10], the focus of much environmental education research remains rooted in individual pro-environmental behaviours and behaviour change [11,12].

Bridging the fields of environmental education and energy research, and building on theories of social practice and practice architectures [13,14], this research investigated the following questions at secondary schools in England:

- What are the patterns of activity that contribute to the environmental impacts of schools and the social practices of school sustainability?

^{*} Environmental Change Institute, Oxford University Centre for the Environment, South Parks Road, Oxford OX1 3QY, UK.

E-mail address: william.finnegan@ouce.ox.ac.uk.

<https://doi.org/10.1016/j.erss.2023.103186>

Received 7 February 2023; Received in revised form 14 June 2023; Accepted 21 June 2023

Available online 5 July 2023

2214-6296/© 2023 The Author. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

- How can an understanding of practices, and the arrangements that support them, enable more effective and transformative whole-school approaches to sustainability?

In this research, a broad organising concept of sustainability has been adopted, rather than a specific focus on energy or climate change in schools. This is motivated by the holistic or whole-school approaches to school sustainability described in more detail below, as well as the observation that school stakeholders fluidly discussed a wide range of environmental issues during the data collection process, for example, responding to prompts about climate and energy by talking about plastics and oceans. The sustainability issues discussed with school stakeholders have clear energy and climate implications, for example the energy consumption and carbon emissions associated with the manufacture of plastics [15] and food production [16], which were further explored through the bundles of social practices identified below.

The article begins by providing additional background on school sustainability, before turning to the theory and methods of this research. The results section is organised around the two research questions and reports on key practices that take place in secondary schools: practices of teaching and learning, practices of catering and eating, and practices of movement and travel. The results section also presents a connection between social practices and whole-school approaches using the practice architecture concepts of semantic, material, and relational spaces. The discussion section includes a series of recommendations for school stakeholders based on the sayings, doings and relating of sustainable school practices.

This research aims to support environmental education research and practice through the application of insights from social theory and energy research to holistic approaches to school sustainability. With data collected between the peak of the Fridays for Future school climate strikes and the UK hosting of the international climate meetings in Glasgow, it captures a moment of high interest in climate change among different school stakeholders, and provides guidance for meaningful climate action in schools.

2. Theory and background

Schools have become the frontlines of the latest wave of youth climate activism, after Greta Thunberg's solitary protest inspired millions of young people around the world to join the Fridays for Future school climate strikes [17]. However, the importance of education and learning to support a transition to a more sustainable society has long been recognised internationally, dating back to the 1977 Tbilisi Declaration at the first intergovernmental conference on environmental education, hosted by the United Nations Environment Programme and United Nations Educational, Scientific and Cultural Organisation (UNESCO) [18]. More recently, the 26th Conference of Parties to the United Nations Framework Convention on Climate Change in 2021 (COP26) resulted in a joint statement from education and environment ministers and the Glasgow work programme on Action for Climate Empowerment which outlines the national responsibilities for climate education under the Paris Agreement [19,20].

A review of climate and energy education found educators mostly focus on individual energy consumption behaviours, with the researchers calling for environmental and sustainability education that, 'more explicitly addresses the role of collective action, multiactor networks, and sociotechnical innovation in shaping energy transition processes' [21]. Researchers have also critiqued sustainability and climate change policy as overly focused on individual choice and behaviour change rather than the broader context of social structures and practices [22]. This research project investigates school sustainability through a social practice lens, exploring the patterns of activity that contribute to a school's environmental impact, and the factors that hold in place unsustainable practices or are required to enable more sustainable

practices.

2.1. Theories of social practice

Research engaging with social practices takes the practice itself as the unit of study and analysis, rather than the people who enact these practices, thus shifting the focus from individual behaviours to the broader patterns of activity, context, and distributed agency of socio-technical systems [23]. Reflecting on the practice turn in philosophy and social theory, including the work of Bourdieu and Giddens, Schatzki defines practices as, 'embodied, materially mediated arrays of human activity centrally organized around shared practical understanding' [24]. Schatzki identifies bundles of practices and the material arrangements that facilitate these practices as central to social analysis [25]. Shove et al. propose that practices are made possible through the interdependent relationships between three elements: material, competence and meaning [26].

A number of researchers have explored the relationship between social practices and learning. Lave and Wenger's seminal work on situated learning identified the participation in social practices as a key aspect of learning, for example, how apprentices move from the periphery to full participation in a community of practice [27]. Building on developments in cultural-historical activity theory by Vygotsky and Leont'ev, Engeström highlighted the possibility of learning to transform practices: 'Expansive learning is a type of learning needed and generated in radical transformations of entire activity systems and fields of activity' [28]. Kemmis – debating the relationship between practices and learning with Schatzki – defined learning as, 'coming to know how to go on in practices, or coming to be able to go on in practices, or coming to participate differently in practices, or, most simply, coming to practise differently' [29].

Social practices can also be understood in relation to Biesta's three domains of the function and purpose of education in society: qualification, socialisation and subjectification [30]. While qualification describes the formal curriculum and the transfer of knowledge and skills to learners, socialisation captures the hidden curriculum of 'cultures, traditions, practices', and subjectification refers to the development of agency and 'our freedom to act or refrain from action' [31]. In school, through both qualification and socialisation, young people are recruited as carriers of practices [32].

2.2. Practice architectures

Building on the theories of social practice above, Kemmis developed the theory of practice architectures to analyse the relationships between practices and arrangements [33]. In this model, practices are interactionally secured in sayings (evident in participants' cognitive understandings), doings (evident in participants' skills and capabilities) and relating (evident in participants' values, feelings, emotions). Practice architectures are the conditions that make practices possible: cultural-discursive arrangements, material-economic arrangements, and social-political arrangements. Practices unfold in the intersubjective spaces (where people encounter one another) that are semantic (as interlocutors in the medium of language), physical (as embodied persons in the medium of activity and work) and social (as social beings in the medium of solidarity and power). Fig. 1 is a greatly simplified version of the theory of practice architectures summary diagram.

Mahon et al. identify a number of features of the theory of practice architectures that distinguish it from other theories of social practice, arguing that it: '(a) politicises practice; (b) humanises practice; (c) theorises relationships between practices; (d) adopts an ontological perspective...; and (e) offers insights pertaining to education' [34]. For example, by extending Schatzki's conception of practices as doings and sayings to a model combining doings, sayings and relating, practice architectures incorporate notions of relationships and power. In addition, the humanising aspect of practice architectures, especially in terms

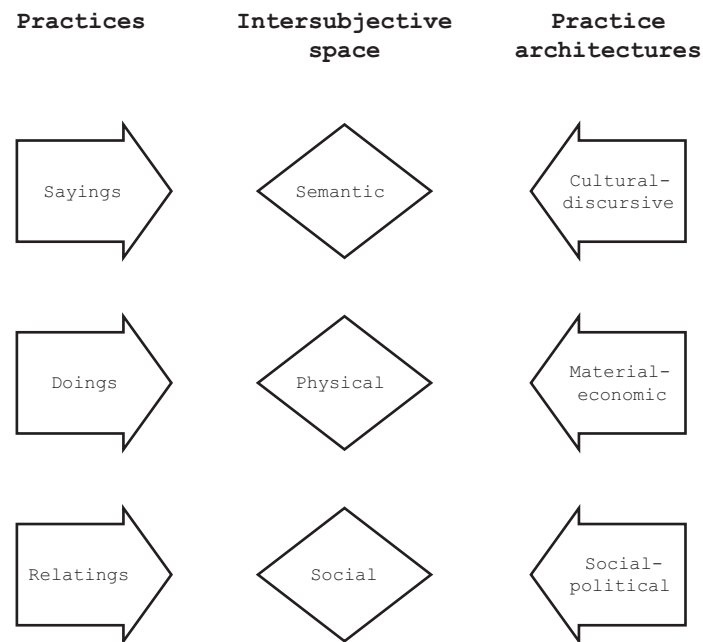


Fig. 1. The theory of practice architectures.
(Adapted from Kemmis [33].)

of the position of human agency and the process of education and learning, was appropriate for this research.

Kemmis uses the metaphor of a river to describe the dialectical relationship between practices and practice architectures: ‘The bed and banks ordinarily enable and constrain the river’s flow. Slowly and gradually, however, the flow of the river causes erosion which slowly alters the river’s course.... Neither the river, nor its bed and banks, are entirely fixed and final; both are to some extent malleable, dialectically adapting to each other as conditions change’ [35]. Kemmis has applied practice architectures to environmental, sustainability and climate education [36–38]. The theory of practice architectures has the potential to offer new insights into the discursive, material and social arrangements that could enable and support more sustainable school practices, complementing existing whole-school approaches. This practice-based research shifts the focus from individual student or staff decisions and behaviours – for example, if a student or teacher composts and recycles waste generated during lunch – to the material infrastructure, situated knowledge, collective meaning, and interpersonal relationships required for a bundle of practices and arrangements to be more sustainable.

2.3. Secondary schools in England

Education is a devolved policy in the United Kingdom, meaning that the governments of Scotland, Wales and Northern Ireland each set their own curricula, funding formulae and systems for assessment and inspection [39]. In England, compulsory education begins at age five, and by the age of 11 pupils start secondary school in what is known as Year 7 or Key Stage 3 [40]. Key Stage 4 begins in Year 10, when students begin to specialise in academic subjects and prepare for their GCSE exams. Key Stage 5 – the final, non-compulsory phase of secondary school, also known as Sixth Form – is when students aged 16 to 18 prepare for A-level examinations (16-year-olds can also pursue apprenticeships, traineeships and other options for further education) [41].

The formal education landscape of England dramatically changed after the Academies Act of 2010 [42]. Academies are schools that receive government funding and are managed by an academy trust (a not-for-profit company), which is a departure from maintained or community schools, which are schools managed by their local authority.

There are currently 3444 state-funded secondary schools in the UK – 2770 (80 %) academies and 674 (20 %) maintained schools [43]. This shift from local authority maintained schools to state-funded but independently managed academies and multi-academy trusts has limited the direct control and support provided by local governments [44].

In England there are 2408 independent schools with a total headcount of 591,954 pupils, or 6.5 % of all primary and secondary school students (many private schools span primary and secondary years, and government statistics don’t provide a more detailed breakdown) [45]. Despite the small percentage of students in privately-funded education in England, the Deaton Review of inequality in Britain found significant disparity between state and independent schools in terms of resources per pupil during schooling, as well as future academic achievement and financial rewards as a result of their education [46]. In this article, the phrases ‘independent school’, ‘private school’, and ‘privately-funded school’ are used synonymously, based on the common usage identified by the Department of Education [47].

2.4. The environmental impact of schools

School sustainability can be understood in terms of the environmental footprint of school buildings and operations. The 2010 UK school carbon management strategy reported the school sector was responsible for 7.3 million tonnes of carbon dioxide emissions in 2006, an increase in 12 % from 1990 [48]. The 2006 schools carbon footprint was broken down into three categories: energy (50 %), procurement (29 %), and travel (16 %). A 2012 report by the Carbon Trust looked specifically at school energy consumption, with the energy demand at a typical school comprised of space heating (60 %), hot water (16 %), catering (12 %), lighting (8 %), and office equipment and other uses (4 %).

The 2016 Building Energy Efficiency Survey, a government review of non-domestic building stock in England and Wales, reported that the education sector is comprised of 47,500 premises with a total floor area of 80 million m² and annual energy consumption of 15,020 GWh [49]. With 40 % of schools constructed between 1940 and 1985, the survey’s abatement model found that energy consumption in the education sector could be reduced by 45 % with a £2.1 billion capital investment. With dramatic increases in the cost of energy in 2022, the Department for

Education surveyed schools about energy suppliers, developed guidance for energy efficiency practices, and provided £500 million for energy efficiency retrofits [50–52].

Guidance on school design and construction emphasises that schools have complex and at times conflicting design requirements in terms of comfort, adaptability and energy performance [53]. The design of schools has an impact on educational outcomes [54,55], and this extends to what is formally and informally taught about sustainability, or what Orr refers to as ‘design as pedagogy’ [56].

2.5. Whole-school approaches to sustainability

Sustainability activities in schools that integrate the environmental performance of facilities, the impact of operations, and learning outcomes for students are often referred to as ‘whole-school’ approaches. An early review of whole-school sustainability programmes provided the following definition of this holistic approach: ‘Whole-school approaches to sustainability incorporate all elements of school life such as school governance, pedagogical approaches, curriculum, resource management, school operations and grounds. Whole-school approaches can imply links and/or partnerships with the local community’ [57].

UNESCO has promoted whole-school approaches, with a recent roadmap for achieving the Sustainable Development Goals through education emphasising this holistic perspective: ‘The entire learning

institution needs to be aligned with sustainable development principles, so that learning content and its pedagogies are reinforced by the way facilities are managed and how decisions are made within the institution’ [58]. The flower model (Fig. 2) captures the various dimensions of whole-school sustainability [59,60].

The collection of exemplary practice in whole-school approaches to sustainability by Mathie and Wals included case studies from sixteen countries across Africa, the Americas, Asia and Europe [61]. Researchers such as Lotz-Sisitka have investigated school sustainability in the Global South, from the formal curriculum and teacher practices to the integration of sustainability into the operations of higher education institutions such as Rhodes University in South Africa [62,63].

2.6. School sustainability frameworks

In the UK, a number of frameworks for sustainable schools have been proposed to operationalise whole-school approaches, including:

- National Framework for Sustainable Schools (2006): this policy – introduced by a Labour government but discontinued by the coalition government of the Conservatives and Liberal Democrats – outlined eight ‘doorways’ to sustainable schools and influenced the Building Schools for the Future investment in new educational facilities [64,65].



Fig. 2. Whole-school sustainability flower model. (Adapted from Wals and Mathie [59].)

- Eco-Schools: the charity Keep Britain Tidy manages the Eco-Schools programme in England (the international network of Eco-Schools is overseen by the Foundation of Environmental Education in Denmark). Eco-Schools offers a structured seven-step process for schools to earn the Green Flag award, which includes developing an action plan based on three of ten potential thematic topics [66].
- WWF-UK COP26: the charity WWF-UK was the educational partner with the UK government when it hosted COP26. In addition to a large presence at the event, WWF-UK worked with a number of partners to develop and disseminate a series of resources, including materials for a climate action workshop in which schools make a ‘promise to the planet’ [67].
- Let’s Go Zero: an initiative of the charities Ashden and Global Action Plan, through Let’s Go Zero schools can sign on to the aspiration of becoming zero carbon by 2030 – as of April 2023 over 2000 schools in the UK had signed up [68]. The campaign includes support in eight thematic areas.

Table 1 outlines the key themes in these four initiatives and the flower model of whole-school sustainability. This thematic comparison illustrates the similarities and differences between these different frameworks, although there is additional potential overlap in the implementation of these programmes. For example, the seven-step process of Eco-Schools includes a step for connecting the chosen themes to the curriculum, and the Let’s Go Zero campaign has developed an online action planner that includes pathways for community, culture, curriculum and campus.

While these existing sustainability initiatives cover many of the dimensions of the whole-school approach, there are notable exceptions. For example, while sustainability content in the curriculum is noted in multiple programmes, they don’t explicitly address how this content is taught and learned – the pedagogy petal of the whole-school flower. In addition, while other initiatives might imply the need for staff training and professional development to accomplish goals related to

sustainability, the whole-school approach highlights this need for capacity building. These initiatives also include aspects not covered by the whole-school model, especially in terms of global connections and future careers.

Of these frameworks, the Eco-Schools programme is the most widely adopted, with the Foundation for Environmental Education reporting that over 59,000 schools in 68 countries participated in Eco-Schools between 1994 and 2019 [69]. In England, 1,478,364 young people attended schools that participate in Eco-Schools in the 2021–2022 school year, with outcomes reported such as 96,580 pupils participating in a litter-pick and 37,865 trees planted on school grounds [70]. Research has found that Eco-Schools initiatives have mixed impacts in terms of learning outcomes and behaviour change, and that the transformative change promised by whole-school approaches remains elusive [71,72].

The sustainable school frameworks above provided an entry point into the conversations with school stakeholders and initial reference point for the reflexive thematic coding of the interview and focus group data. A number of the schools that participated in this study were involved in both the Eco-Schools and Let’s Go Zero programmes, and both initiatives were discussed in interviews.

3. Methods

This study focuses on secondary schools in England. Secondary schools were chosen, rather than primary schools, as they are complex institutions with specialised staff. In addition, students in sixth form could reflect on their school experience and future plans, and were at an age where they might have participated in the Fridays for Future school climate strikes. The twelve schools that participated in this study (see Table 2) were initially recruited through the UK Schools Sustainability Network, which emerged after the climate strikes to connect young people and the teachers that supported their climate action in regional and national networks. This network was used to identify a school staff member (either teaching or non-teaching) with a role connected to sustainability (either formally or informally) that could serve as a gateway to other stakeholders. As the first round of schools to join this research project were predominantly independent schools, additional state schools were recruited through referrals from other schools and personal relationships. All of the state schools participating in this study were academies.

In each school, semi-structured interviews were conducted with different school stakeholders, which may have included one or more representatives from the leadership, finance, and facilities teams, teachers, governors, and parents, adding up to 67 interviews (with 72 interview subjects, as a small number of interviews included multiple

Table 1
Thematic comparison of sustainable school frameworks.

Whole-school approaches to sustainability ('flower' model)	Sustainable schools framework ('doorways')	Eco-schools England topics	WWF-UK school promises to the planet	Ashden Let's Go Zero campaign
Vision, ethos, leadership and coordination	Inclusion and participation		Culture	
Curriculum			Curriculum	Curriculum
Pedagogy and learning				
Institutional practices	Food and drink Energy and water Purchasing and waste Buildings and grounds Travel and traffic	Healthy living Energy Water Waste Litter School grounds Biodiversity Transport	Campus	Food Energy Water Procurement Waste Nature Transport
Capacity building				
Community connections	Local well-being		Community	
Not explicitly covered by the whole-school flower model	Global dimension	Global citizenship Marine	Careers	

Table 2
Participating schools by type/category.

	State	Independent	Total
Number of schools	6	6	12
Average pupil population [73]	1516	808	1162
Proportion of pupils in this study	65 %	35 %	100 %
Location: Greater London	0	4	4
Location: Berkshire	1	2	3
Location: Buckinghamshire	2	0	2
Location: Oxfordshire	3	0	3
Single-sex schools	1 (girls' school)	2 (girls' schools)	3 (girls' schools)
Religious schools	0	1 (Quaker)	1
International Baccalaureate schools	0	1	1
State academies	6	N/A	6
State maintained schools	0	N/A	0
Academically selective state schools	2 (grammars)	N/A	2

stakeholders with the same role or related roles) across the twelve schools. An additional nine interviews were conducted with school sustainability experts with experience working in multiple schools, including two staff members at local authorities that provided support for school sustainability. Interviews lasted between 20 and 60 min. School interviews began in January 2021 and continued during the spring and summer school terms in the 2020–2021 academic year. As this research took place during the COVID-19 pandemic, during which school policies restricted visitors, most of the interviews were conducted using video conferencing software.

Focus groups were conducted with students at ten of the schools, with 61 sixth form students participating. The focus group format, using the same questions as the interviews, was chosen to maximise the potential student voice while also responding to the safeguarding requirements of the participating schools. Table 3 shows the number of interviewees and focus group participants by stakeholder group and school type, and in the results section these are referred to using a code combining the school type and stakeholder group (for example, S1-L would be a member of the senior leadership at a state school, and I2-G would be a governor at an independent school).

Transcripts of the interview and focus group recordings were coded using reflexive thematic analysis to iteratively develop and refine the themes shared in the results section [74]. This analysis was also informed by critical discourse analysis, especially in terms of the relationship between language and social practice [75].

The primary limitation of this research is related to it being conducted while schools were responding to the coronavirus pandemic, which greatly disrupted school operations. While COVID-19 also limited access to the participating schools, it was possible to visit ten of the participating schools, and observations and notes from these relatively brief visits – and any additional materials shared by interview subjects about school sustainability activities – informed the interpretation of qualitative data described above. Previous research contends that research participants are able to talk about social practices, and that both interviews and focus groups are appropriate methods for practice-based research [76,77]. The large number of interviewees and focus group participants was also an effort to overcome the limitations posed by COVID-19. The decision to set the boundaries of the research at individual schools, in terms of the participating stakeholders, is also a potential limitation of this research given the growing importance of centralised teams for multi-academy trusts and affiliated independent schools. The discussion below includes recommendations for future research based on the limitations of this study.

4. Results

This section begins with general observations about school sustainability before turning to aspects of the two research questions identified in the introduction. Three bundles of social practices in secondary schools have been identified related to sustainability: teaching/learning, catering/eating and movement/travel. Whole-school approaches to

Table 3
Research participants by stakeholder group and school type.

	State (S)	Independent (I)	Other	Total
Facilities (Fa)	3	6		9
Finance (Fi)	3	5		8
Governor (G)	5	5		10
Leadership (L)	7	5		12
Parent (P)	5	11		16
Teacher (T)	9	8		17
Student (S) ^a	29	32		61
Expert (E)			9	9
Total	61	72	9	142

^a Students participated in focus group conversations rather than individual interviews.

sustainability were also integrated with the theory of practice architectures, which are represented below through diagrams of the semantic, material and social dimensions of school sustainability practices. The tables in this section include representative quotations from the stakeholder interviews and student focus group discussions.

The interviews and focus group conversations revealed the importance at each school of the eco-leads, the person at each school acting as a formal or informal champion for sustainability, often a young teacher or staff member. These eco-leads were working with small groups of students to raise the profile of sustainability in their schools – in the classroom, in the canteen, and in the culture of the school – in response to growing concerns about climate change. A variety of stakeholders recognised the importance of sustainability, especially reducing the use of energy consumed and waste generated through school practices. However, transformative, school-wide responses were very limited, and most of the schools in this study were early in their journeys to becoming more sustainable.

The response of schools to climate and sustainability was markedly different between state and independent schools. The discourses around sustainability at private schools appeared responsive to the interests of students and parents as customers in a competitive marketplace. At the state schools in this study, sustainability efforts were often led by staff and teachers that expressed concern about limited involvement from students, while initiatives at independent schools had more student involvement and leadership, and these schools in general appeared more supportive of student voice and empowerment. As better resourced institutions, the independent schools in this study were also more likely to have formally supported a staff member as an eco-lead through dedicated time and funding. This marks a potential state versus independent divide in education for environmental sustainability.

Staff from the leadership and finance teams at both state and independent schools identified the lack of financial resources as hampering their responses to climate change. As a state school bursar commented:

If someone came along and said, ‘Right, here’s a million pounds, make the school as energy efficient as you can,’ and gave me two years to plan it and do it properly – rather than try and spend it in six months, which is the usual thing with government funding – then we would be able to do all those sorts of things.

(S1-Fi)

The headteacher at an independent school reflected that for her school to fully integrate sustainability it would take, ‘some kind of radical rethinking, a bit of bravery, and quite a lot of money’ (I6-L).

4.1. Whole-school approaches to sustainability

The whole-school approach to sustainability introduced above was represented as a flower, with petals for the various dimensions of sustainability across the sociotechnical system of a school and vision at the centre. Table 4 connects these components to the conversations with school stakeholders.

The whole-school model illustrates how sustainability cuts across various activities and roles at a school. For example, the community energy project mentioned above touches on the technical infrastructure related to electricity on the school site, the opportunity to study real-world climate and energy solutions in the classroom, and relationships between the school and the wider community. The whole-school model also hints at the combinations of sayings, doings and relatings reflected in practices, and the parallel practice architectures that maintain them. However, at the schools in this study, the implementation of sustainability campaigns often boiled down to individual choices of different actors in a school, for example student behaviour in the canteen, or the bursar’s assessment of capital projects.

At all of the schools included in this study, the senior leadership team – especially the head teacher – and the school governors controlled key decisions with respect to whole-school sustainability. At the same time,

Table 4

Summary of findings and sample quotations related to whole-school approaches to sustainability.

	Summary of findings	Quotations
Vision, ethos, leadership and coordination	The culture of a school – codified into values, transmitted by the leadership – can be an obstacle or an enabler to school sustainability. For example, the school in this study with the highest level of engagement from the governors was a Quaker school with sustainability as one of the seven school values.	‘And an important part of being a Quaker is you should be judged by what you do, and how you behave, perhaps more even than what you say and what you think. So a lot of it is about delivering sustainability in action and in practice. And I think that’s been really important for us’ (I2-Fi).
Curriculum	The content of teaching and learning connects sustainability with the educational purpose of school and the national curriculum of England. Stakeholders talked about the limited inclusion of sustainability in subjects as they are currently taught, with the exception of geography and the International Baccalaureate course on environmental systems and societies.	‘[School should] promote understanding how much of an impact [students] have on the environment. And that kind of comes down to lessons and being taught about it... but it’s not like it’s not part of the curriculum for all of us’ (S3-S).
Pedagogy and learning	The methods of teaching sustainability may differ from conventional teaching practices, for example, teachers mentioned attempts to coordinate within and across subjects and consider the learning journeys/pathways of students over the course of secondary school. Stakeholders also referred to integrating contact with nature, local problem solving, system thinking, and global issues into learning.	‘The way that we live, you use a toilet and you flush it and you don’t know understand how sewage works, or you turn on the tap, you don’t understand how the water arrived or you throw something in the recycling bin and you don’t really know where it goes. And [we need] much more understanding of how you fit in the wider system’ (S2-T2).
Institutional practices	The operation of a school combines the social and technical aspects of the institution, for example the consumption of energy to heat and light school buildings. Most of the schools in this study have older buildings that would be costly to renovate to modern sustainability standards. Procurement was disconnected from the daily life of schools, with significant decisions taking place on multi-year cycles, for example, choosing the energy supplier, caterer, waste collector, etc.	‘[Sustainability] needs to be on the agenda. It needs to be one of those regular [questions], ‘where are we at with our environmental policy?’ It needs to be another safeguarding question, where every meeting, it’s there. You know, ‘What’s going on? What’s the progress?’” (S2-G).
Capacity building	The training and ongoing professional development of teaching and non-teaching staff is essential to the long-term impact of sustainability campaigns. Citing resistance to changes in school practices to be more sustainable, stakeholders	‘And I think the frustration for me is you’ve got people putting so much effort into trying to do the right thing for climate change, and you’ve got others who just can’t be bothered’ (I3-Fa3).

Table 4 (continued)

	Summary of findings	Quotations
	emphasised the importance of addressing both the skills and the story of practices, empowering the school community with action competence, and breaking through the mindset of ‘can’t be bothered’.	
Community connections	Sustainability activities can extend beyond the school estate into surrounding communities. Parents spoke of how their children brought concepts and practices into their homes, as well how environmental awareness can flow from the home back to school. Stakeholders also spoke of support provided by local authorities, partnerships with community energy projects, and the possibility of schools serving as hubs for sustainability.	‘We joined a [community energy] scheme where it’s a community run organization. They sell shares to raise the capital for solar projects and they have, free of charge to the school, covered [a school building] with solar panels’ (S3-Fi).

responsibility for different aspects of managing the school was delegated to specialised roles related to finance, procurement, building and energy management, and teaching different subjects. While private schools control the fees charged to pupils, state-funded schools have no control over the per pupil funding provided through the National Funding Formula, and must bid in a competitive process for limited capital funding, limiting how proactive they can be in implementing whole-school approaches. In terms of the regulation and reputation of schools, Ofsted inspections of state-funded schools do not consider school sustainability, and school performance is primarily assessed through student exams, especially the subject-specific GCSE and A-Level qualifications.

4.2. The social practices of school sustainability

This research engaged a wide range of secondary school stakeholders in conversations about the social practices of sustainability. Interviews and focus groups covered the priorities of that stakeholder and the accomplishments they have observed in terms of how their school was responding to the climate crisis, as well as school activities, desired changes that were beyond the control of that stakeholder, and the sayings, doings and relatings required to support more sustainable practices. Schools were represented as unique institutions, in terms of both the built environment of the facilities and grounds, and the human dimension of how they are used and managed. In terms of energy use profiles, the expert interviewees noted that schools are similar to offices but have different daily and annual patterns, with shorter days and longer holidays. One example of how broader social patterns might conflict with more sustainable practices is the installation of onsite renewable energy, specifically the current business model for installing arrays of solar panels on school buildings, as the peak annual production takes place during the summer holidays when schools are largely empty.

The interview subjects were able to provide examples of practices, as well as the arrangements that are required to support the transformation to more sustainable practices. For example, with respect to waste management (recycling, composting), schools often identified and provided the material (bins for different types of waste) and supported the development of skills and capabilities (signage and assemblies to train people to put waste in the correct bin) but lacked the story and relationships (the motivation and sense of collective ownership to actually put waste in the correct bin). A number of themes were identified in the

reflective thematic analysis of the interview and focus group transcripts which have been organised into three bundles of practices and arrangements that capture the main patterns of activities that take place over the course of a school day (Fig. 3). The first bundle relates to practices of teaching and learning, which reflect the core purpose of schools, something that interview subjects across all stakeholder groups emphasised. The bundle of practices for catering and eating is based on many comments about dining options, especially meat alternatives, food waste and packaging, as a tangible part of the school experience for most stakeholders was participating in a midday meal at school. Another bundle of practices represents movement within a school building over the course of the day (another unique feature of school versus office activity), travel between home and school, and school trips.

It is worth noting that these three bundles are not comprehensive in terms of the full environmental impact and carbon footprint of schools, omitting certain types of resource consumption and technical infrastructure. Rather, the bundles were chosen as they represent key aspects of daily school experiences for the majority of the school community. In each section below, a table is presented with the most commonly identified themes related to the bundle of practices and arrangements for each stakeholder group, with a representative quotation included for reference.

4.2.1. Practices of teaching/learning

Teacher practices involve a wide range of pedagogical approaches and activities related to the qualification, socialisation and sub-jetification of learners. Teaching as a practice is very much connected to the sayings and thinking in Kemmis' model, with respect to the use of language and development of cognitive understanding. This is also related to how lessons align with the ideas in the national curricula and the assessment of qualifications, and how educators might link a variety of subjects to relevant issues outside of the formal curriculum. In terms of the material element of practices, teaching and learning in schools generally takes place in classrooms which have been purpose-built and furnished to support this fundamental purpose of schools, with additional facilities to support more specialised learning, for example sport, music, drama, design and technology, etc. The relational component of practices for teaching connects with teacher relationships to other school stakeholders and to the culture of their school, as well as their emotional connection to teaching, especially considering the demands and pressures on teachers.

In terms of sustainability, many teachers mentioned the use of paper and printing as a tangible form of waste resulting from teaching activity, especially when coupled with a lack of recycling practices in their school. The use of technology in teaching practices had changed over the

careers of the teachers interviewed, with a recent shift to digital learning materials hastened by how schools responded to the coronavirus pandemic. While this may have decreased the impact of paper and printing, the energy use of information technology in the classroom and home, as well as cloud services for data storage, and the sourcing and disposal of devices like student Chromebooks, raised questions of additional environmental impacts. The energy performance of the classroom also intersected with teacher practices and the use of technology, for example the interaction between content delivered by a teacher using a projector and the use of daylighting and zoned lighting control. To limit the spread of COVID-19, air circulation was increased in schools through natural ventilation, which often meant heating classrooms while the windows were left open. When discussing the missing sayings and relatings that could support more sustainable teacher practices, stakeholders referenced a lack of climate literacy, habits of older teachers, and resistance to change, especially given time pressures and demanding nature of teaching. Reflections by stakeholder on practices of teaching and learning are presented in Table 5.

The energy implications of practices of teaching and learning were primarily related to the consumption of electricity in the classroom for lighting and a range of instructional technologies. The increasing use of computers in the classroom and dissemination of content digitally can be seen in the context of a growing body of research on digital innovations and climate change [78,79].

As the quotations above illustrate, a wide range of perspectives were presented on the use of technology in the classroom, the way sustainability is (or is not) included in the curriculum, and the relationship between teaching/learning and future careers and decisions. While teachers recognised that the practices of teaching can have a positive and negative environmental impact, they emphasised that the education of young people – and the preparation of young people for future careers and as members of society – is the biggest environmental impact of schooling.

4.2.2. Practices of catering/eating

By providing lunch for hundreds of pupils and staff, schools participate in practices of catering and eating. This service tends to be contracted to a catering company that sources, prepares and serves the food. The discourses around food in schools often focused on cost-effective preparation of healthy meals. Food also evokes stories about identity and culture. The material arrangements related to food includes the kitchen equipment used for cooking and refrigeration and objects used for packaging, serving and eating the food, which may be washable and reusable, or disposable. In terms of relationships, dining is a shared experience for the school community.

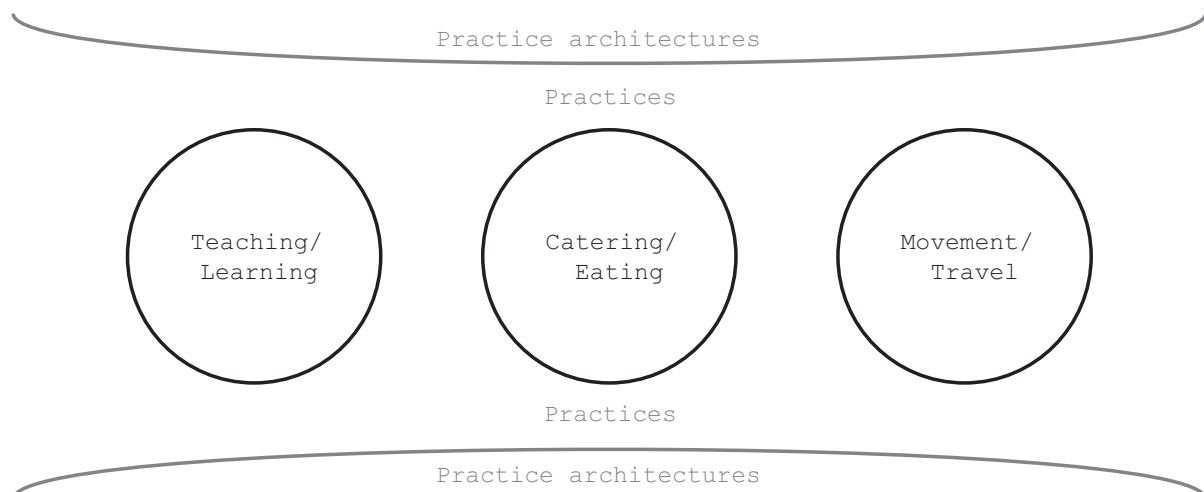


Fig. 3. Bundles of practices and arrangements at schools.

Table 5
Stakeholder themes and sample quotations related to practices of teaching/learning.

	Themes	Quotations
Facilities	Technology in classroom, Heating/lighting control	'Every classroom has got a projector. Majority of the projectors are fairly modern... I'm sure they're a lot more energy efficient than the ones that were out four or five years ago.' (S3-Fa).
Finance	Technology in the classroom, Green design	'There's an important educational aspect to this [green building programme]. I don't think we've got this quite right yet, if I'm honest, but you know, showing students: this is what we've done, this is the investment, this is the actual financial benefit and the environmental benefit of what we've done' (I2-Fi).
Governor	Carbon literacy and footprint, Green careers	'Schools are just not getting how much employment the green economy is going to provide, and how many courses and further education there is out there, and grants and support and capacity for all the people that are going through the school at the moment, they're going to need to know this stuff' (S6-G).
Leadership	Curriculum and cross-curricular	'We're going to talk about where environmental messages fit into the existing curriculum. So, we're not rewriting stuff or creating a massive policy of a document which boringly sits on a shelf and annoys people from time to time. We're just talking about it, and, by talking about it, it'll happen. And that's because it's now being framed as part of actual, real world action' (S2-L).
Parent	Curriculum and cross-curricular, Environmental awareness, Project-based learning	'It needs to be a central core part of the curriculum because this is just as important as history, maths, English, science. And, in fact, it could be taught in all of those different strands... the whole way through school' (I4-P3).
Teacher	Action competence, Critical awareness, Systems thinking	'I think that success is something that I'm not going to see. You know, the successes are a child who makes a decision because that decision has an ecological consequence' (I1-T2).
Student	Curriculum and cross-curricular, Environmental awareness	'I'd like to see the school just kind of promote more kind of eco consciousness within the student body, I'd like to see the school kind of actively push that a bit more.' (S4-S).
Expert	Carbon literacy and footprint, Heating/lighting control	'This is where the <i>smart</i> needs to come in – enabling the user, helping them to do the right thing, but not usurping their authority. So don't turn the lights on for them, but turn them off when they're not there. And allow them to turn them off when they are there. There's quite a lot of the smart lighting systems are not smart at all. We got all the lights on in the classroom, but actually turn them off by the whiteboard.' (E2).

When reflecting on the environmental impact of schools, the canteen loomed large, especially for students. There were frequent references to wasted food and the rubbish and litter related to food packaging. Staff commented on the food wasted by students; students criticised the options, portions and quality provided in the canteen. School staff referred to initiatives to phase out single-use plastic, for example plastic water bottles, and install reusable water bottle refill stations. Students and parents also spoke about the availability (or lack of availability) of vegetarian and vegan options. While one school was completely vegetarian (as required by their landlord) stakeholders at other schools reflected on attempts to institute meat-free Mondays, with varying levels of success. Schools were forced to change lunch practices in response to COVID-19 policies that limited dining in lunchrooms and required takeaway options, which had implications for food-related waste, although some schools implemented compostable food packaging. Some school staff were particularly sensitive to potential eating disorders of pupils, and worried about the language of strict, rule-based diets. A summary of themes and example quotations by stakeholder on the practices of catering and eating are presented in Table 6.

While the practices of catering and eating included the use of electricity and gas in kitchens and canteens, and the lifecycle impacts of materials and waste, the primary energy and climate implications are related to the carbon footprint of food choices, especially of meat versus plant-based diets [80].

The quotations above show how the material nature of the procurement, preparation and distribution of food is enmeshed in the culture of the institution, for example the (un)acceptability of removing meat from the menu. The practices of catering and eating also reflect a difference in state versus independent schools, especially boarding schools that provide three meals a day. A member of the leadership team at a state school mentioned the financial implications of more sustainable food practices:

I would love to be more considerate in our cafe, for example, in terms of things we're selling, and what they're made of, and the packaging and whatnot. Then again, there can be a knock-on cost to doing that, which, if you're a 'Free School Meals' child, puts certain items on the menu out of the market for you.... Cost for the family rather than for the school is something that's always at the forefront of my mind and can be a barrier to perhaps having some of the projects and things that we would rather do.

(S3-L1)

4.2.3. Practices of movement/travel

Eleven of the twelve secondary schools included in this study were on campuses with multiple buildings, and over the course of the school day students and staff walk through these spaces – between classrooms, between buildings, and across the school grounds. Students and staff also must travel from home to school, journeys taken through active travel (walking, cycling), public transportation (buses, trains), and by car. Four of the state schools in this study were local schools with a small catchment, meaning that students lived close enough to school to walk or cycle. The other eight schools (two grammar schools and six independent schools) drew from a wider catchment, and included both urban schools with strong public transport links and boarding schools with much less daily travel (although they also had a number of international students that travel by plane multiple times a year). Teaching and non-teaching staff frequently drove to school, and mentioned the lack of affordable housing close to their schools. Another travel practice related to education is school trips, with some schools (especially independent schools) offering multiple international trips a year related to sports and subjects. With international travel put on hold due to COVID-19, some schools found suitable domestic alternatives that could be reached by coach.

The practice of movement through a school on a timetable of short periods has implications for school sustainability. The opening of doors –

Table 6

Stakeholder themes and sample quotations related to practices of catering/eating.

	Themes	Quotations
Facilities	Catering, vegetarian and vegan	'We use an external caterer... and I think as part of the new contracts, we may need to look at the carbon usage of the companies that we're looking at, and maybe that needs to be part of the contract' (S1-Fa).
Finance	Food waste, water bottles and fountains	'That's a classic example of where COVID has accelerated change. You know, we were saying to students, 'bring your own bottle', so we've put these little [water bottle refill] stations in around the place. That's gonna make a big difference for us right now.' (I2-Fi).
Governor	Vegetarian and vegan	'On the food side, possibly the biggest, single, easy win would be to take beef completely off the menu. We can't influence that. What we can do is measure its consumption' (I2-G1). 'I disagree with that. I think we can' (I2-G2). 'Okay, maybe we can. Whether we can influence it sufficiently, I don't know' (I2-G1).
Leadership	Food waste, packaging	'So small things that I think can make a big difference: less packaging, less waste through packaging. Actually because of COVID we've gone back to everything being wrapped up, and I really don't like that' (S6-L).
Parent	Composting, food waste, vegetarian and vegan	'I'm vegan... my girls are vegan, and it's been quite hard to get the school to cater for them properly. My daughters are often given food they shouldn't be given because the staff aren't aware of what vegan means. I've been asking for better labelling, better provision, you know, building more vegan choice or plant-based choice into the actual offering for everyone' (I6-P1).
Teacher	Catering, food waste, packaging, vegetarian and vegan	'Building up that kind of broader systems thinking in the students, you know, when they take a banana, and then they don't eat it. Where has that banana actually come from? How's it got here to our school? And, you know, just throwing it in the bin, what's the impact of that? And I would apply this to the teachers as well' (I5-T).
Student	Choices and portions, food waste, vegetarian and vegan	'I think the main thing that you can do is be vegetarian. If there was more of an education into like your diet and how much impact [eating] meat has on the environment. We don't really know where the meat in the cafeteria actually comes from.' (S3-S).
Expert	Not discussed	

from the classroom to a corridor and from a building to outside – circulates the air and impacts heating requirements. When students and staff leave a classroom, they may leave the lights and other equipment on, unsure of when the room will be used next and whose responsibility it is to switch things off. While motion sensors for lighting and the standby mode for devices can improve energy efficiency in the context of the use and circulation patterns of a school, many school staff reported empty classrooms with the lights on after hours. In terms of promoting more sustainable travel such as cycling to school, stakeholders discussed the materials (cycle paths, racks, sheds, showers), sayings (bike-ability training), and relatings (events like bike to school days to increase motivation and sociability) of the practice of cycling. Parents also revealed concerns about the safety of children cycling to school, which

ties into ideas of protection from harm, and led to parents driving their children to school. Students, teachers, governors, parents and members of the leadership team reflected on the high carbon footprint of international trips, which were part of the privileged culture of some schools. Themes and example quotations by stakeholder on the practices of movement and travel are included in Table 7.

The practices of movement and travel are related to the Scope 1 greenhouse gas emissions of school vehicles and the Scope 3 emissions from student and teacher commuting and school trips and other 'business travel' [81]. Practices related to school travel extend beyond the school gates, and must be understood within the broader context of public policy and technical innovation, for example initiatives to decrease air pollution from transport in London [82].

The excerpts from the interviews and focus group conversations illustrate the frequent mentions of advances in and barriers to more active travel to school. Through these three bundles of practices and arrangements, we can understand the school experience for young people and other school stakeholders – their movement to and from and through the school, their time in lessons which accounts for the majority of the school day, and the daily shared experience of meals. The lens of practice architectures highlights the layered sayings, doings and relatings that comprise practices that are environmentally sustainable and unsustainable. We now turn to how the three layers of practice architectures – cultural-discursive, material-economic and social-political arrangements – can help school stakeholders better understand and support whole-school approaches to sustainability.

4.3. Practice architectures and whole-school approaches

In the previous section, life in a school was understood through a series of specific bundles of practices. At this point we attempt to look holistically at how schools work as semantic, physical and social institutions. In the sections that follow, each dimension of the theory of practice architectures is explored separately. The figures below reflect an effort to systematically map the key elements of each dimension based on the stakeholder interviews. The boxes on the left represent semantic, material and social components of school life, and the ovals connected on the right represent how sustainability could be incorporated into each component.

4.3.1. Practice architectures: semantic dimension

Fig. 4 was developed based on the stakeholder interviews to map the semantic dimension of school practice architectures – where the 'sayings' of practices are shaped by the language and ideas of practice arrangements – including sections for the language of governance/leadership, teaching, and student voice. This illustrates the influence of both the culture of a single school, as well as the broader culture of education and assessment set by national, local and institutional policies, on the understandings of sustainability in a school reflected in the sayings and thinking of school stakeholders. Student voice also emerged as a theme in the interviews, as some schools have more formal mechanisms for students to share opinions and a culture of student empowerment. Students were also very interested in strategies to communicate about environmental issues, and engage both students and staff that didn't currently prioritise sustainability.

4.3.2. Practice architectures: material dimension

Fig. 5 represents the material dimension of school practice architectures – where the material-economic arrangements enable the 'doings' of practices – based on the stakeholder reflections on the school buildings and grounds and the material flows through them. This material dimension also encompasses the technology used to operate the building (heating, lighting) as well as support the practices identified above (classroom teaching, food preparation). The opportunities for sustainability in this space depend on the material arrangements, such as the design of school buildings, as well as economic arrangements, such

Table 7

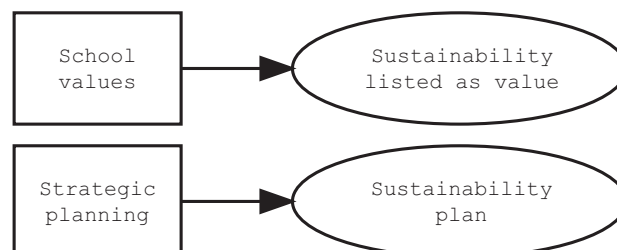
Stakeholder themes and sample quotations related to practices of movement/travel.

	Themes	Quotations
Facilities	Active travel, cars	'Yet another big [impact] is transport: people driving to school and children being dropped off by car. There'll be someone that lives probably no more than five or ten minutes walking distance but mum or dad is dropping them off. And staff driving to school as well – there's a member of staff that literally is about a three-minute walk but drives every day' (S3-Fa).
Finance	Active travel, infrastructure, public transport	'So, in the last two or three years, we've really encouraged girls to cycle to school, you know, we offer cycle training and storage for their bikes and all of those sort of things. But we still have got to get over a mindset... and I think that there's a gap still between the theory and the practice.' (I6-Fi).
Governor	Infrastructure, school trips	'I think to be totally honest, the one area that stands out for me at the school is the international travel. One of the great things about the school is it offers lots of opportunity – for people to play sports abroad, for people to go on various different trips abroad, experience different cultures, and all of that. Absolutely, it all has a really strong educational meaning and worth. However, it still has a detrimental effect on the environment, and, how we reconcile that and how we have a real debate about that, I think is very difficult' (I3-G).
Leadership	Active travel, cars	'Because of the demographic of a lot of our parents who are quite wealthy... they all have big, you know, SUVs, and they like to drop their children off at school in those cars. And the pandemic has impacted on that – they don't want to be them traveling on trains, and buses, because they're worried, so they dropped them off [by car]' (I6-L).
Parent	Active travel, carbon offsetting, cars, school trips	'My son walks back from school, or we'll go on to an after-school activity or something where either he tries to walk or take a bicycle or something like that' (S4-P1).
Teacher	Active travel, cars, infrastructure, public transport, school trips	'Obviously, getting the teachers at the school every day is probably the important thing. But another thing to think about is what is your school trip? And do you want to try and get by train even though that's really difficult, to go to Paris or somewhere, if it's easier to go by coach or probably a flight?' (S2-T1)
Student	Cars, infrastructure, public transport, school trips	'I think the school does quite well in terms of the journey to school. The vast majority of people living outside walking distance would be using school buses, and cars and car-share if there's no bus available. Although it has to be said that the age of our school transport is so old that the kind of fumes that those things pump out – I don't even stand behind that sort of thing' (S4-S).

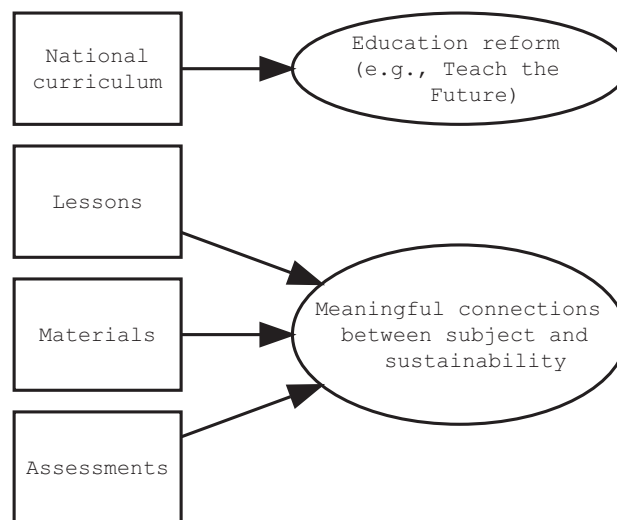
Table 7 (continued)

	Themes	Quotations
Expert	Data and analytics	'So we're building at the moment an app to essentially act as a bit of a survey tool. So they would fill it out in terms of tracking how people travelled to school, and then it will give them feedback on the carbon footprint and what happens if they change' (E9).

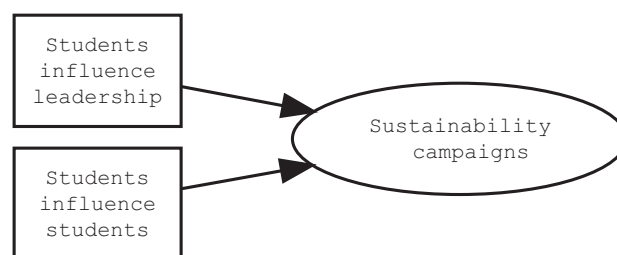
Leadership and governance



Teaching



Student voice

**Fig. 4.** Semantic dimension of school sustainability practices.

as procurement decisions and suppliers. Schools can also participate in a changing energy system, in which institutions not only consume energy but are also producers through the installation of onsite renewables,

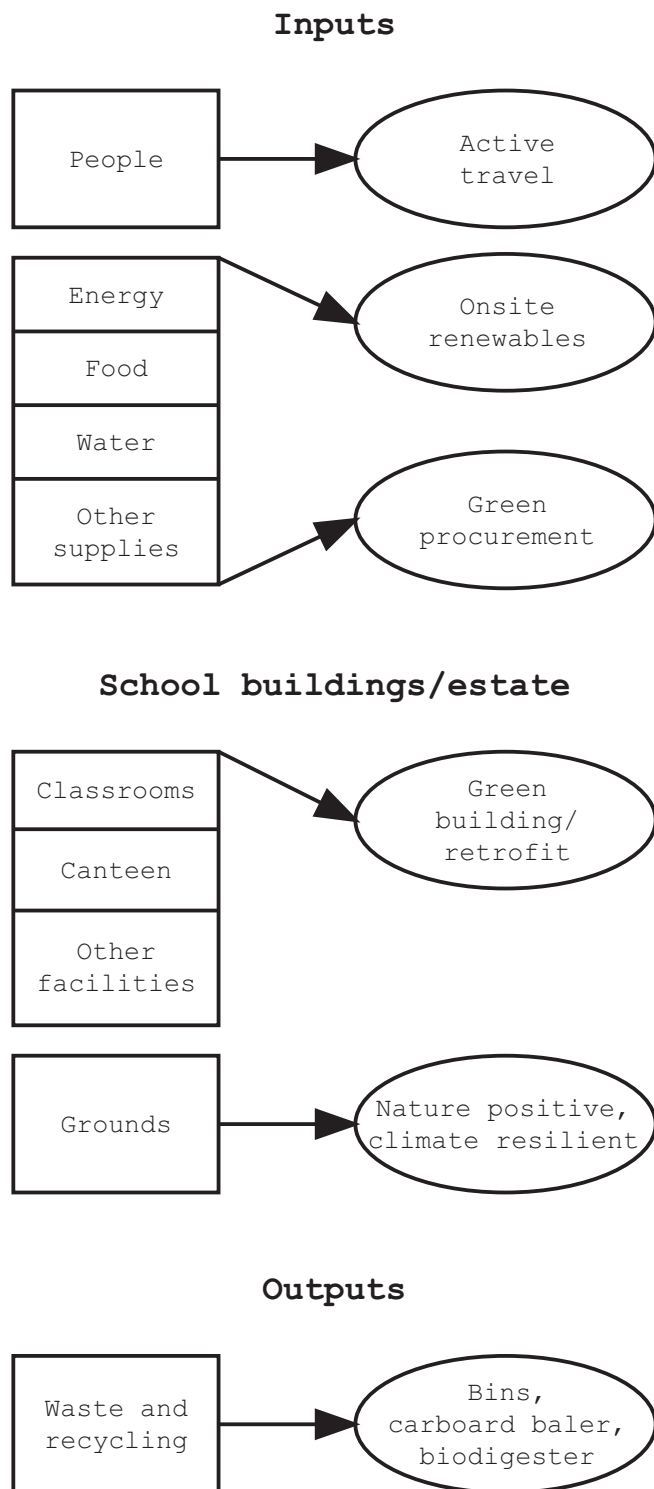


Fig. 5. Material dimension of school sustainability practices.

which can be supported by local financing and produce local benefits through community energy initiatives. While not explored in this diagram, in Kemmis's model this dimension is where skills and capabilities are evident through participants' doings, 'as embodied persons in physical space-time, in the medium of activity and work' [83].

4.3.3. Practice architectures: social dimension

Fig. 6 presents the social space of school practice architectures – where the 'relatings' of practices are made possible by the relationships

and power dynamics of people – based on reflections on the different stakeholders inside and outside a school with a variety of potential roles and relationships that support sustainability. These roles could include (using 'eco' for brevity): eco lead at the local authority or multi-academy trust, eco society for representatives from multiple schools in a local authority or multi-academy trust, eco governor, eco lead on school staff, eco club open to all students, eco council with elected representatives from each year group, eco prefects/ambassadors in sixth form that lead the eco council and represent the school in the eco society and other networks, and an eco committee with representatives from all stakeholders that works through thematic task forces.

These diagrams are an attempt to map the complex social, material and semantic systems that are secondary schools, while also illustrating the cross-cutting nature of sustainability in educational institutions. One goal of this analysis is to reveal key intervention points that would enable and sustain more sustainable schools, which are discussed in the recommendations below.

5. Discussion

In this research project, a wide range of stakeholders at a dozen secondary schools in England shared their experiences of sustainability, discussing challenges, opportunities and successes. The inclusion of both models of whole-school sustainability and theories of social practice shifted the focus from the choices and behaviours of individuals, as characterises much environmental and sustainability education research and practice, to a more holistic perspective on the transformation of the sociotechnical system of a school to respond to the climate and nature crises. In particular, the inclusion of practice architectures as a theoretical framework was novel and fruitful, and illustrates the potential of bridging the disciplines of environmental education and energy research.

This research captured a range of perspectives from school stakeholders, illustrating different understandings of bundles of practices in schools that are related to sustainability. The number of participants involved in semi-structured interviews and focus group conversations, and their diverse roles and expertise, is a strength of this research. Whole-school approaches to sustainability have been proposed as supporting systems thinking and change, incorporating all school activities and stakeholders. Initiatives, such as the Green Flag certification scheme of Eco-Schools, provide a process and thematic framework for schools to systematically engage with environmental issues. However, programmes like this often engage a small percentage of the school community, are seen as a time-bound activity rather than a long-term process, and can be limited to a 'box-ticking exercise' rather than lead to school-wide transformation. The combination of whole-school approaches with a practice-informed understanding of the sayings, doings and relatings of school life could allow schools to more holistically – semantically, materially and socially – engage with sustainability.

The findings above also reflect differences in how state versus independent schools are engaging with sustainability, echoing the Deaton Review of inequality in Britain [84]. This research indicates that disparities in terms of funding and academic performance also translate into how schools are responding to environmental issues such as climate change and biodiversity loss. This potential disparity in school sustainability could have far reaching consequences in terms of personal and collective climate resilience, at a time when educationalists are calling for the state or public education system to be reimagined to support climate mitigation and adaptation [85].

The business model of privately-funded independent schools allows them to invest in material infrastructure to improve the sustainability of operations, from building programmes to equipment upgrades. The independent schools involved in this research were more likely to have teachers or other staff with a formal sustainability role and resources to achieve goals related to sustainability. These private schools were also more likely to encourage student empowerment and voice, and were

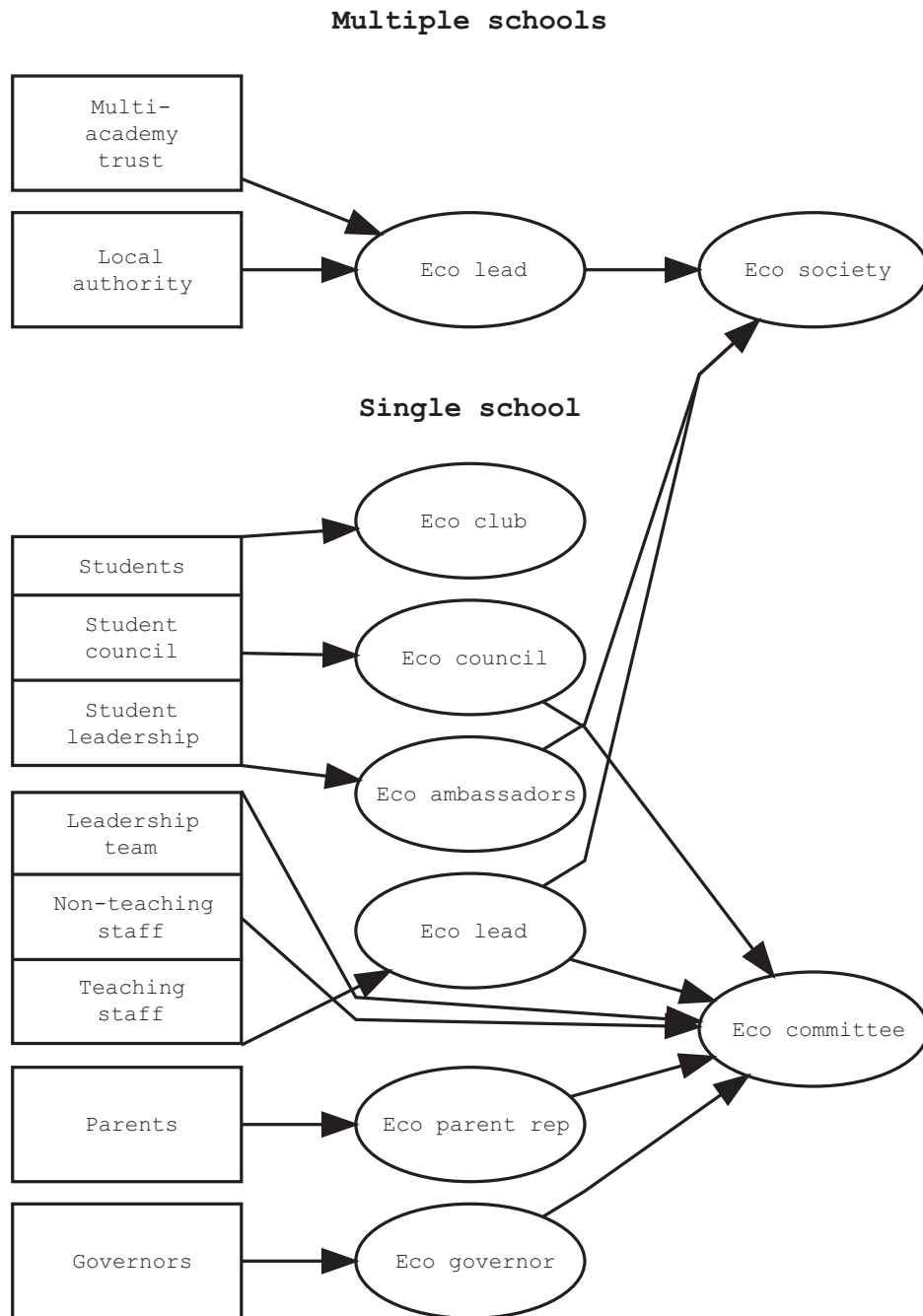


Fig. 6. Social dimension of school sustainability practices.

responsive to the concerns of students and parents, actively marketing their sustainability activities in the competitively marketplace of private education. At the same time, there are certain contradictions inherent in independent schools talking about sustainability while continuing activities, such as international trips, that have very large carbon footprints, as well as questions of equity and justice raised by the relative carbon footprint between independent versus state school pupils (and their families).

5.1. Recommendations

The findings above have been synthesised into a series of recommendations for policy makers and educational institutions, building on the different dimensions of the theory of practice architectures.

5.1.1. Whole-school & practice-informed

Schools that aspire to be more sustainable must take a whole-school approach to sustainability. The guidance and support offered by Eco-Schools, WWF, Let's Go Zero, BERA, NAEE and UNESCO (among others) can help institutions engage with sustainability holistically in terms of buildings, operations and teaching across a range of subjects and thematic areas. However, the lens of social practices and practice architectures reveals that whole-school approaches must also respond to the broader context of both the patterns of activity of school life and the discursive, material and social arrangements required to enable more sustainable activities. The findings of this research indicate that sustainability begins with a commitment by the school leadership team and governors to address sustainability holistically, recognising that it is connected to the social practices of school life and the arrangements that enable or constrain patterns of activity. Whole-school approaches will

often need to extend beyond a single school, especially given the shift towards multi-academy trusts and both the centralised decision-making and economies of scale provided by these trusts.

5.1.2. Sayings

The semantic dimension of practice architectures, as explored in the analysis above, reflects how sustainability is talked about in a school. For the school stakeholders involved in this study, especially teachers, there was recognition that the language of sustainability needs to permeate the school system, from the national curriculum to the school values and strategic planning. This goes beyond holding a school assembly or other one-off event, and requires that the story of sustainability be fully integrated into the culture of a school. While curriculum reform is a slow process, the recent Tracked Changes Review of the national curriculum of England commissioned by the student-led campaign Teach the Future illustrates opportunities for sustainability education across multiple subjects, which can inform teacher practices [86].

5.1.3. Doings

The stakeholders involved in this study – bursars, maintenance teams, governors overseeing capital projects – often wanted to do more when it came to sustainability, but were constrained by lack of funding and the continuous process of accessing competing priorities for limited resources. For schools to walk the talk of sustainability, there is a clear and pressing need for a major school renovation, energy efficiency, and decarbonisation (including onsite renewables) programme funded by the government. This is a long-term investment, reducing operating costs and improving comfort, which also will positively impact learning outcomes. Additional funding would also make it possible for schools to prioritise sustainability in procurement decisions, such as their energy supplier. Support should also be provided for schools in the areas of food and transport, for example the provision of healthy, environmentally-sustainable dining options for all students, and additional infrastructure and incentives for active travel.

5.1.4. Relatings

The eco-leads at different schools were important participants in this research, serving as gateways to other stakeholders and shouldering much of the work of sustainability, often informally and on top of other responsibilities. Creating and supporting clear roles for sustainability at all levels – governors, staff, students – of educational institutions will result in clearer ownership and accountability, as well as improved relationships between different stakeholders. This involves firmly placing sustainability on the agenda of governors and staff, in a similar fashion to an issue like safeguarding, and providing time, resources and support to stakeholders with formal roles related to sustainability. Sustainability also provides opportunities to cultivate relationships beyond a single school – across a multi-academy trust, between nearby state and independent schools, linking the school with the surrounding community, and through emerging networks supporting educators and learners interested in climate action.

5.1.5. Adaptation and resilience

Returning to Kemmis's metaphor of the river of practices, the relationship between a practice (river) and the arrangements that enable it (riverbanks) depends on a healthy ecosystem, in which the river can find its meandering course through a floodplain. In this research, a number of factors were identified that have fortified the riverbank of school practice architectures – old building stock, school cultures and the habits and mindsets of stakeholders, and policies that underfund schools and focus on the siloed assessment of qualifications. For schools to meaningfully respond to the climate crisis, system-wide reforms are required to reshape the river of practices and support adaptation and resilience in a time of change and uncertainty.

5.1.6. Future research

The COVID-19 pandemic limited the ability to directly observe and document practices in this research, with reliance instead on remotely conducted semi-structured interviews and focus group conversations. Future research could further explore environmentally-related practices and practice architectures in schools using a variety of methods. For example, researchers could work in a more embedded way at a single school using observational and ethnographic methods to identify bundles of practices and arrangements, and the dynamics of social practices in response to changes in school policies or other interventions. Researchers could also investigate additional layers of regulatory and financial oversight through interviews with other actors, for example at local authorities, government agencies and multi-academy trusts.

Kemmis described learning as 'coming to practice differently'. In the dynamic relationship between practice, practitioner and practice architectures, the river of educational practices is resisting changes that would enable more sustainable school activity, despite the interest of many school stakeholders and the aspirations of the DfE climate and sustainability strategy. For schools to transform into more climate resilient institutions that prepare young people for a future shaped by climate change, we must quickly and collectively learn and change.

6. Conclusions

This research builds on traditions in environmental and sustainability education, incorporates social theory often absent from this field, and responds to urgent calls for the education sector to respond to the climate and nature crises. Schools are an important component of the UK net-zero strategy, and over 2000 schools have joined a campaign declaring their ambition to be zero carbon by 2030. However, the schools in this study illustrate that educational institutions have a long way to go in their sustainability journey, and are in need of support from the government, especially when it comes to the capital investment required to improve the energy performance of schools.

Guided by the research questions mentioned above, this article set out to explore the social practices of secondary schools, and how these relate to whole-school approaches to sustainability. School stakeholders identified social practices related to teaching/learning, catering/eating, and movement/travel as patterns of activity contributing to their schools' environmental footprints. The methods of interviews and focus groups proved successful in terms of gathering perspectives on practices from a wide range of stakeholders. The theory of practice architectures was utilised to analyse practices as sayings, doings and relatings, leading to recommendations for policy makers and school leadership to overcome the challenges of whole-school approaches and enable more sustainable schools.

This research contributes to whole-school approaches to sustainability, using theories of social practice and practice architectures to provide an ever broader, more holistic foundation for schools to respond to the climate crisis. There are real obstacles to schools decreasing their environmental impact in a way that increases the climate resilience of local communities and learners. This research has clear policy implications, both in terms of aligning national education policy – funding, curriculum, inspections – with the government's net-zero goals, and in terms of the freedom of academies, multi-academy trusts, and independent schools to make the case – both a business case, and one related to their educational mission – for bold climate action.

Schools aspire to prepare young people for the future. As the ability to participate in practices that are more environmental sustainability is increasingly seen as an essential component of life, work and study, educational institutions have an important role to play in both teaching about and modelling the practices of sustainability. This practice-informed, whole-school approach to sustainability transcends a single academic subject or a particular student interest. Sustainability in schools, to put it simply, is about what we do, what we talk about, and how we relate to one another. For schools to play a transformative role

in averting environmental crises, environmental sustainability must be fully integrated across the sayings, doings and relatings both inside and outside of classrooms.

Funding

This work was supported by the Engineering and Physical Sciences Research Council.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

References

- [1] Department for Education, Sustainability and climate change: a strategy for the education and children's services systems, URL, GOV.UK, 2022. <https://www.gov.uk/government/publications/sustainability-and-climate-change-strategy/sustainability-and-climate-change-a-strategy-for-the-education-and-childrens-services-systems>. (Accessed 29 November 2022) (WWW Document).
- [2] L. Dunlop, E.A.C. Rushton, Putting climate change at the heart of education: is England's strategy a placebo for policy? Br. Educ. Res. J. (2022), [berj.3816](https://doi.org/10.1002/berj.3816) <https://doi.org/10.1002/berj.3816>.
- [3] DFES, Sustainable schools, URL, <https://webarchive.nationalarchives.gov.uk/ukgwa/20110113120152mp/>. (Accessed 29 November 2022) (<http://www.teachernet.gov.uk/sustainableschools/index.cfm>, WWW Document, n.d.).
- [4] D.W. Orr, *The Nature of Design: Ecology, Culture, and Human Intention*, Oxford University Press, New York, 2002.
- [5] B.P. Warner, M. Elser, How do sustainable schools integrate sustainability education? An assessment of certified sustainable K–12 schools in the United States, J. Environ. Educ. 46 (2015) 1–22, <https://doi.org/10.1080/00958964.2014.953020>.
- [6] D. Godoy-Shimizu, S.M. Hong, I. Korolija, Y. Schwartz, A. Mavrogianni, D. Mumovic, Pathways to improving the school stock of England towards net zero, Build. Cities 3 (2022) 939–963, <https://doi.org/10.5334/bc.264>.
- [7] L. Dias Pereira, L. Neto, H. Bernardo, M. Gameiro da Silva, An integrated approach on energy consumption and indoor environmental quality performance in six Portuguese secondary schools, Energy Res. Soc. Sci. 32 (2017) 23–43, <https://doi.org/10.1016/j.erss.2017.02.004>.
- [8] J.A. Samuels, M.J. Booyens, Chalk, talk, and energy efficiency: saving electricity at South African schools through staff training and smart meter data visualisation, Energy Res. Soc. Sci. 56 (2019), 101212, <https://doi.org/10.1016/j.erss.2019.05.022>.
- [9] B.K. Sovacool, D.J. Hess, R. Cantoni, Energy transitions from the cradle to the grave: a meta-theoretical framework integrating responsible innovation, social practices, and energy justice, Energy Res. Soc. Sci. 75 (2021), 102027, <https://doi.org/10.1016/j.erss.2021.102027>.
- [10] S. Hampton, R. Adams, Behavioural economics vs social practice theory: perspectives from inside the United Kingdom government, Energy Res. Soc. Sci. 46 (2018) 214–224, <https://doi.org/10.1016/j.erss.2018.07.023>.
- [11] J.E. Heimlich, N.M. Ardoin, Understanding behavior to understand behavior change: a literature review, Environ. Educ. Res. 14 (2008) 215–237, <https://doi.org/10.1080/13504622.2008.2148881>.
- [12] T. Marcinkowski, A. Reid, Reviews of research on the attitude–behavior relationship and their implications for future environmental education research, Environ. Educ. Res. 25 (2019) 459–471, <https://doi.org/10.1080/13504622.2019.1634237>.
- [13] E. Shove, M. Pantzar, M. Watson, *The Dynamics of Social Practice: Everyday Life and How It Changes*, SAGE, Los Angeles, 2012.
- [14] S. Kemmis, *Transforming Practices: Changing the World With the Theory of Practice Architectures*, 2022.
- [15] Ellen MacArthur Foundation, *The New Plastics Economy: Rethinking the Future of Plastics and Catalysing Action*, World Economic Forum, Cowes, 2017.
- [16] H. Dimbleby, *National Food Strategy: Independent Review - The Plan*, Department for Environment, Food & Rural Affairs, London, 2021.
- [17] B. Bowman, Fridays for Future: How the Young Climate Movement Has Grown Since Greta Thunberg's Lone Protest, *The Conversation*, 2020.
- [18] UNEP, Intergovernmental Conference on Environmental Education, Tbilisi, USSR, 14–26 October 1977: Final Report - UNESCO Digital Library, 1978.
- [19] I. Messetchkova, Co-chairs conclusions of Education and Environment Ministers Summit at COP26, in: UN Climate Change Conference (COP26) at the SEC – Glasgow 2021, 2021. URL, <https://ukcop26.org/co-chairs-conclusions-of-education-and-environment-ministers-summit-at-cop26/>. (Accessed 29 November 2022) (WWW Document).
- [20] UNFCCC, Glasgow Work Programme on Action for Climate Empowerment, UNFCCC, 2021.
- [21] S.N. Jorgenson, J.C. Stephens, B. White, Environmental education in transition: a critical review of recent research on climate change and energy education, J. Environ. Educ. 50 (2019) 168, <https://doi.org/10.1080/00958964.2019.1604478>.
- [22] E. Shove, Beyond the ABC: climate change policy and theories of social change, Environ. Plan. A 42 (2010) 1273–1285, <https://doi.org/10.1068/a42282>.
- [23] E.L. Trist, K.W. Bamforth, Some social and psychological consequences of the longwall method of coal-getting: an examination of the psychological situation and defences of a work group in relation to the social structure and technological content of the work system, Hum. Relat. 4 (1951) 3–38, <https://doi.org/10.1177/001872675100400101>.
- [24] T. Schatzki, Introduction: practice theory, in: T. Schatzki, K. Knorr-Cetina, E. von Savigny (Eds.), *The Practice Turn in Contemporary Theory*, Routledge, New York, 2001, p. 11.
- [25] T.R. Schatzki, A primer on practices: theory and research, in: J. Higgs, R. Barnett, S. Billett, M. Hutchings, F. Trede (Eds.), *Practice-based Education*, Brill, Rotterdam, 2012, pp. 13–26.
- [26] E. Shove, M. Pantzar, M. Watson, *The Dynamics of Social Practice: Everyday Life and How It Changes*, SAGE, Los Angeles, 2012.
- [27] J. Lave, E. Wenger, *Situated Learning: Legitimate Peripheral Participation, Learning in Doing*, Cambridge University Press, Cambridge [England]; New York, 1991.
- [28] Y. Engeström, *Learning by Expanding: An Activity-theoretical Approach to Developmental Research*, second edition, Cambridge University Press, New York, NY, 2015.
- [29] S. Kemmis, A practice theory perspective on learning: beyond a 'standard' view, Stud. Contin. Educ. 43 (2021) 280–295, <https://doi.org/10.1080/0158037X.2021.1920384>.
- [30] G. Biesta, Risking ourselves in education: qualification, socialization, and subjectification revisited, Educ. Theory 70 (2020) 93, <https://doi.org/10.1111/edth.12411>.
- [31] G. Biesta, Risking ourselves in education: qualification, socialization, and subjectification revisited, Educ. Theory. 70 (2020) 93, <https://doi.org/10.1111/edth.12411>.
- [32] E. Shove, M. Pantzar, M. Watson, *The Dynamics of Social Practice: Everyday Life and How It Changes*, SAGE, Los Angeles, 2012.
- [33] S. Kemmis, *Transforming Practices: Changing the World With the Theory of Practice Architectures*, 2022.
- [34] K. Mahon, S. Kemmis, S. Francisco, A. Lloyd, Introduction: practice theory and the theory of practice architectures, in: K. Mahon, S. Francisco, S. Kemmis (Eds.), *Exploring Education and Professional Practice: Through the Lens of Practice Architectures*, Springer, Singapore, 2017, pp. 1–30, https://doi.org/10.1007/978-981-10-2219-7_1, 16.
- [35] K. Mahon, S. Kemmis, S. Francisco, A. Lloyd, Introduction: practice theory and the theory of practice architectures, in: K. Mahon Francisco (Ed.), *Exploring Education and Professional Practice: Through the Lens of Practice Architectures*, Springer, Singapore, 2017, pp. 1–30, https://doi.org/10.1007/978-981-10-2219-7_1, 83.
- [36] S. Kemmis, R. Mutton, Education for sustainability (EfS): practice and practice architectures, Environ. Educ. Res. 18 (2012) 187–207, <https://doi.org/10.1080/13504622.2011.596929>.
- [37] S. Kemmis, Addressing the climate emergency: a view from the theory of practice architectures, J. Environ. Educ. 53 (2022) 42–53, <https://doi.org/10.1080/00958964.2021.2017830>.
- [38] S. Kemmis, *Transforming Practices: Changing the World With the Theory of Practice Architectures*, 2022.
- [39] L. Sibiet, J. Jerrim, *A Comparison of School Institutions and Policies Across the UK*, Education Policy Institute, London, 2021.
- [40] Department for Education, National curriculum in England: framework for key stages 1 to 4, URL, GOV.UK, 2014. <https://www.gov.uk/government/publications/national-curriculum-in-england-framework-for-key-stages-1-to-4/the-national-curriculum-in-england-framework-for-key-stages-1-to-4>. (Accessed 19 March 2023) (WWW Document).
- [41] Department for Education, School leaving age, GOV.UK. . URL, <https://www.gov.uk/known-when-you-can-leave-school>. (Accessed 13 June 2023) (n.d., WWW Document).
- [42] T. Male, The rise and rise of academy trusts: continuing changes to the state-funded school system in England, School Leadersh. Manag. 42 (2022) 313–333, <https://doi.org/10.1080/13632434.2022.2095996>.
- [43] Department for Education, Schools, pupils and their characteristics, academic year 2022/23, URL, <https://explore-education-statistics.service.gov.uk/find-statistics/school-pupils-and-their-characteristics>, 2023. (Accessed 11 June 2023) (WWW Document).
- [44] S.J. Courtney, Mapping school types in England, Oxf. Rev. Educ. 41 (2015) 799–818, <https://doi.org/10.1080/03054985.2015.1121141>.
- [45] Department for Education, Schools, pupils and their characteristics, academic year 2022/23, URL, <https://explore-education-statistics.service.gov.uk/find-statistics/school-pupils-and-their-characteristics>, 2023. (Accessed 11 June 2023) (WWW Document).
- [46] C. Farquharson, S. McNally, I. Tahir, *Education Inequalities, IFS Deaton Review of Inequalities*, Institute for Fiscal Studies, 2022.
- [47] Department for Education, Types of school, GOV.UK. . URL, <https://www.gov.uk/types-of-school/private-schools>. (Accessed 8 April 2023) (n.d., WWW Document).

- [48] Department for Children, Schools and Families, Climate Change and Schools: A Carbon Management Strategy for the School Sector, 2010 (London).
- [49] Department for Business, Energy & Industrial Strategy, Building Energy Efficiency Survey: Education Sector, 2014–15, 2016 (London).
- [50] Department for Education, DfE energy survey: spring 2022, GOV.UK. . URL, <http://www.gov.uk/government/publications/dfe-energy-survey-spring-2022>. (Accessed 8 April 2023) (n.d., WWW Document).
- [51] Department for Education, Energy efficiency: guidance for the school and further education college estate, GOV.UK. . URL, <https://www.gov.uk/government/publications/energy-efficiency-guidance-for-the-school-and-fe-college-estate/energy-efficiency-guidance-for-the-school-and-further-education-college-estate>. (Accessed 8 April 2023) (n.d., WWW Document).
- [52] Department for Education, How we are supporting schools and colleges to be energy efficient, URL, The Education Hub, 2022. <https://educationhub.blog.gov.uk/2022/12/06/how-we-are-supporting-schools-and-colleges-to-be-energy-efficient/>. (Accessed 8 April 2023) (n.d., WWW Document).
- [53] J. Palmer, D. Mumovic (Eds.), CIBSE TM57: Integrated School Design, CIBSE Technical Memoranda, CIBSE, 2015.
- [54] P. Barrett, F. Davies, Y. Zhang, L. Barrett, The impact of classroom design on pupils' learning: final results of a holistic, multi-level analysis, Build. Environ. 89 (2015) 118–133, <https://doi.org/10.1016/j.buildenv.2015.02.013>.
- [55] C.K. Tanner, Effects of school design on student outcomes, J. Educ. Adm. 47 (2009) 381–399, <https://doi.org/10.1108/09578230910955809>.
- [56] D.W. Orr, The Nature of Design: Ecology, Culture, and Human Intention, Oxford University Press, New York, 2002.
- [57] K. Henderson, D. Tilbury, Whole-school Approaches to Sustainability: An International Review of Whole-school Sustainability Programs, Macquarie University, Sydney, 2004, p. 9.
- [58] UNESCO, Education for Sustainable Development: A Roadmap - UNESCO Digital Library, 2020, p. 28.
- [59] A.E.J. Wals, R.G. Mathie, Whole school responses to climate urgency and related sustainability challenges: a perspective from northern Europe, in: M.A. Peters, R. Heraud (Eds.), Encyclopedia of Educational Innovation, Springer Singapore, Singapore, 2022, pp. 1–8, https://doi.org/10.1007/978-981-13-2262-4_263-1.
- [60] R.G. Mathie, A.E.J. Wals, Whole School Approaches to Sustainability: Exemplary Practices From Around the World, Wageningen University, Education & Learning Sciences, 2022, <https://doi.org/10.18174/572267>.
- [61] R.G. Mathie, A.E.J. Wals, Whole School Approaches to Sustainability: Exemplary Practices From Around the World, Wageningen University, Education & Learning Sciences, 2022, <https://doi.org/10.18174/572267>.
- [62] H. Lotz-Sisitka, O. Shumba, J. Lupele, D. Wilmot (Eds.), Schooling for Sustainable Development in Africa, Springer International Publishing, Cham, 2017, <https://doi.org/10.1007/978-3-319-45989-9>.
- [63] M. Togo, H. Lotz-Sisitka, Exploring a systems approach to mainstreaming sustainability in universities: a case study of Rhodes University in South Africa, Environ. Educ. Res. 19 (2013) 673–693, <https://doi.org/10.1080/13504622.2012.749974>.
- [64] Department for Children, Schools and Families, s3+: Sustainable Schools Self-evaluation for Local Authorities Who Support Sustainable Schools (No. DCSF-00697-2009), 2008 (London).
- [65] A.M. Moncaster, P. Simmons, Policies and outcomes for UK sustainable schools, Build. Res. Inf. 43 (2015) 452–464, <https://doi.org/10.1080/09613218.2015.1005518>.
- [66] Keep Britain Tidy, Home, Eco schools. . URL, <https://www.eco-schools.org.uk/>. (Accessed 3 December 2022) (n.d., WWW Document).
- [67] WWF-UK, COP26 Glasgow: our climate our future, WWF. . URL, <https://www.wwf.org.uk/get-involved/schools/cop26>. (Accessed 3 December 2022) (n.d., WWW Document).
- [68] Ashden, Let's go zero, URL, <https://letsgozero.org/>, 2020. (Accessed 10 April 2023) (n.d., WWW Document).
- [69] A.C.D. Funder, N. Andreou, P.K. Sharma, Changing Together - Eco Schools (1994–2019), Foundation for Environmental Education, 2019.
- [70] Keep Britain Tidy, Eco-schools impact report, URL, https://c-6.net/virtualdocs/eco-schools_impactreport2021-2022/. (Accessed 5 February 2023) (n.d., WWW Document).
- [71] J. Boeve-de Pauw, P. Van Petegem, Eco-school evaluation beyond labels: the impact of environmental policy, didactics and nature at school on student outcomes, Environ. Educ. Res. 24 (2018) 1250–1267, <https://doi.org/10.1080/13504622.2017.1307327>.
- [72] L.-M.U. Schröder, A.E.J. Wals, C.S.A. (Kris) van Koppen, Analysing the state of student participation in two eco-schools using Engeström's Second Generation Activity Systems Model, Environ. Educ. Res. 26 (2020) 1088–1111, <https://doi.org/10.1080/13504622.2020.1779186>.
- [73] Department for Education, Find and compare schools in England, GOV.UK. . URL, <https://www.gov.uk/school-performance-tables>. (Accessed 5 October 2022) (n.d., WWW Document).
- [74] V. Braun, V. Clarke, Using thematic analysis in psychology, Qual. Res. Psychol. 3 (2006) 77–101, <https://doi.org/10.1191/1478088706qp0630a>.
- [75] N. Fairclough, Language and Power, Third edition, Routledge, Taylor & Francis Group, London; New York, 2015.
- [76] R. Hitchings, People can talk about their practices: people can talk about their practices, Area 44 (2012) 61–67, <https://doi.org/10.1111/j.1475-4762.2011.01060.x>.
- [77] A.L. Browne, Can people talk together about their practices? Focus groups, humour and the sensitive dynamics of everyday life: can people talk together about their practices? Area 48 (2016) 198–205, <https://doi.org/10.1111/area.12250>.
- [78] E. Vrain, C. Wilson, L. Kerr, M. Wilson, Social influence in the adoption of digital consumer innovations for climate change, Energy Policy 162 (2022), 112800, <https://doi.org/10.1016/j.enpol.2022.112800>.
- [79] F. Creutzig, D. Acemoglu, X. Bai, P.N. Edwards, M.J. Hintz, L.H. Kaack, S. Kilis, S. Kunkel, A. Luers, N. Mijolevic-Dupont, D. Rejeski, J. Renn, D. Rolnick, C. Rosol, D. Russ, T. Turnbull, E. Verdolini, F. Wagner, C. Wilson, A. Zekar, M. Zumwald, Digitalization and the Anthropocene, Annu. Rev. Environ. Resour. 47 (2022) 479–509, <https://doi.org/10.1146/annurev-environ-120920-100056>.
- [80] X. Xu, P. Sharma, S. Shu, T.-S. Lin, P. Ciais, F.N. Tubiello, P. Smith, N. Campbell, A. K. Jain, Global greenhouse gas emissions from animal-based foods are twice those of plant-based foods, Nat. Food 2 (2021) 724–732, <https://doi.org/10.1038/s43016-021-00358-x>.
- [81] EAUC, Standardised Carbon Emissions Framework for Further and Higher Education (SCEF), Department for Education, 2022.
- [82] Greater London Authority, Pollution and air quality, London City Hall. . URL, <https://www.london.gov.uk/programmes-strategies/environment-and-climate-change/pollution-and-air-quality>. (Accessed 14 June 2023) (n.d., WWW Document).
- [83] S. Kemmis, Transforming Practices: Changing the World With the Theory of Practice Architectures, 2022, p. 97.
- [84] C. Farquharson, S. McNally, I. Tahir, Education Inequalities, IFS Deaton Review of Inequalities, Institute for Fiscal Studies, 2022.
- [85] K. Facer, Climate change: how should public education respond? Forum 61 (2019) 207, <https://doi.org/10.15730/forum.2019.61.2.207>.
- [86] Teach the Future, Curriculum for a Changed Climate: A Tracked Changes Review of the Curriculum, 2022 (Macclesfield).