Sustainable school cultures: A democratic methodology for transitioning schools to net-zero

Cyrus Golding and Katy Millis

1. Abstract

There is a pressing need for scholarly work which explores the specific ways in which schools can reduce their carbon emissions on a path to achieving net-zero by 2050 in line with UK government guidelines. This article makes several key contributions to literatures on net-zero, education for environmental sustainability (ESD) and school-based professional cultures. 1) It provides what we understand to be the first complete practical methodology that enables schools to account for their carbon emissions; 2) it argues that this data is key for galvanising pro-environmental student actions in which students can become agents of change supporting schools on their net-zero journey; 3) we develop the concept of 'sustainable school cultures' to argue that carbon accounting is more than a technical process and must begin by and be enabled through creating a distinctive ethos of methodological transparency and collaboration.

2. Introduction

The importance of schools in managing and mitigating the effects of the climate emergency is becoming increasingly apparent. The Department for Education (DfE) (2022: np) strategy on sustainability and climate change provides explicit policy direction for English schools to 'reduce direct and indirect emissions from education and care buildings… to meet legislative targets and provide opportunities for children and young people to engage practically in the transition to net-zero'. These legislative targets relate to the UK's legal responsibilities to reach net-zero by 2050 (Deben et al., 2020).

Net-zero is a concept which emerged from physical climate science (Fankhauser et al., 2022). This is a shift away from stabilising levels of atmospheric CO_2 towards keeping within the 1.5 degrees of warming above pre-industrial levels as called for by the 2015 Paris Agreement. The key idea is that there is a balance between the release of greenhouse gas and its removal from the atmosphere (Allen et al., 2022). However, net-zero is not without its challenges as often the largest amount of emissions are beyond direct control of schools themselves. These emissions are classed as Scope 3 emissions meaning they are generated up and down an organisation's supply chain (Jones, 2023). In short, Scope 1 emissions relate to emissions produced within a school and under its direct control. Scope 2 emissions are those from externally supplied energy.

Despite increasing pressures from internal and external stakeholders for schools to account for and reduce their carbon footprint, including from children themselves in the form of climate activism and school sustainability committees, there remains a lack of an agreed methodology for school carbon accounting and, more broadly, a paucity of academic literature on reaching net-zero that pertains specifically to schools. This makes it difficult for all but the most well-resourced schools to begin accounting for their emissions. The few schools that have begun to do this have done so by devising their own methodologies often in conjunction with external consultants (see A Planet Mark x ICS, 2023). This methodological opaqueness masks the political decisions behind carbon calculations (Blakey, 2021), and potentially underreports emissions and limits opportunities for student/ teacher participation by framing the calculation of carbon footprints as a purely technical endeavour.

At the same time as attempts to account for and reduce the carbon emissions on school sites, there has also been a parallel effort to increase Education for Sustainable Development (ESD) in school curricula. ESD can take many forms from educating children about the causes and consequences of climate change to taking actions in their own lives that can make a difference (Greer et al., 2023). Whilst some authors have begun to acknowledge that ESD is most effective when students are exposed to real-world data and problems (Rap et al., 2022), we wish to take these arguments a step further to argue that effective ESD should see students directly involved in debating and critiquing carbon accounting methodologies and using this information to inform pro-environmental action in and around the school site. This ethos of methodological transparency, data sharing and involvement of students is core to the concept of *sustainable school cultures* which we develop here and acts as the ethical foundation to how schools approach their work around net-zero targets.

This article therefore makes two original contributions. The first is technical in that it provides what we understand to be the first complete methodology for school-based carbon accounting (assessing Scope 1, 2 and 3). We do so as a starting point for discussion across different schools in the UK and internationally not to advocate for a one-size-fits all methodology. The second is we argue we argue that students themselves are a crucial component in helping schools get to net-zero both through their actions being informed by school carbon emissions data and when they are empowered to interrogate the methodology behind school carbon data.

3. Democratising school carbon calculations

There are difficulties in reconciling planetary-scale environmental changes with the types of actions that should be taken at the school-scale. The Independent Schools Council (2023) highlights case studies of sustainable actions undertaken by UK schools which involve actions such as switching school energy supplies away from gas in favour of renewable supplies, offsetting emissions through tree planting and introducing charging points for electric vehicles. Yet, there are a paucity of examples of where students are intimately involved in the decision-making or monitoring process for these projects in a way which empowers them to make change and validates the practical application of their environmental knowledge. Moreover, without calculating a school's carbon emissions first, it makes monitoring the carbon reduction of any student interventions difficult and inhibits the ability of students to understand the most important areas in which emissions can be reduced.

Students' own ideas are valuable in shaping the priorities related to the teaching of environmental change in the school curriculum (e.g. Dunlop et al., 2022; Rushton, 2021; Dunlop and Rushton, 2021). However, there is a lack of work that explores how students can be seen as collaborators in the journey to net-zero on school sites, particularly in regards to the technical aspects of emissions calculations. We suggest, this is not only important as a form of democratising environmental knowledge, but it also transfigures the spaces and locales in which climate change actions can be undertaken to the more local scales of the school site.

There is therefore an inherent politics to the scales at which climate change is and should be tackled as local scales may hide the structural factors such as economies based on consumption, which continue to contribute to climate change, species loss and land degradation (e.g. Wright and Nyberg, 2015; Baer, 2012). Yet, it might well be at the local scale of the school site that students can exercise their ideas across a whole range of sustainability-related issues from purchasing decisions to the temperature of classrooms that not only create learning opportunities for the application of ESD, but potentially more ethical decisions rooted in everyday, collaborative decision-making (Gibson-Graham et al., 2013).

It is this interconnection between the school site, operational expertise, curricula and students that has been neglected in literature on enabling sustainable transitions. Some recent work has foregrounded the importance of dialogue between teachers and students and the importance of short and longer-term goals in enabling climate action (Tappel et al., 2023; Almeida and Vasconcelos, 2013). Whilst others have argued that sustainable transitions in any institution occur when there are 'openings' or disruptions to the policy landscape which allow for new innovations and ideas to take hold (Lawhon and Murphy, 2011). It could be argued that as the realities of climate change are being felt in concert with increasing pressure from students (including climate anxieties), organisational pressure from groups such as 'Let's Go Zero' (letsgozero.org) and recent government policies mean there is a window in which meaningful action between students and school emission reduction can start to take place.

A concern about the contribution of UK schools to climate change is not new. A 2008 report explored the carbon emissions from English schools and estimated that across the whole school estate 45% of emissions are from procurement, 37% from buildings, 16% from travel and transport and 2% from waste making up an estimated 9.4 million tonnes of carbon dioxide (Sustainable Development Commission, 2008). The report showcases early examples of strategies schools were taking to reduce their emissions including advocating for the idea of creating targets for emissions reductions and the idea that we might one day create opportunities to compare carbon emissions data between schools. Whilst it is far from universal, some councils have developed their own policies to reach net-zero by 2030 and provided guidance to schools. For example Hertfordshire Council has provided guidance to maintained schools to cut electricity and reduce carbon emissions (Herefordshine Council, 2017). Yet, there is a tendency to focus mainly on electricity as this has immediate cost reduction implications for schools but calculating the emissions from the whole school operation, including procurement (Scope 3), which is where most emissions are likely to lie, is more complex.

In the following section we provide what we regard to be the first methodology of accounting for a school's carbon footprint. There is a risk however that the methodology behind such calculations is not open to proper democratic scrutiny from students, school staff and the broader school community, thus obscuring the political choices through which carbon is calculated potentially creating crude trade-offs between consulting students and arriving a quantified carbon footprint. In outlining our methodology we invited students and other stakeholders to question the assumptions behind it and advocate for the 'making public' of carbon data else we mask the political deliberations which go into such methodologies and close down opportunities for meaningful discussion and debate (see also Latour, 2005; Braun and Whatmore, 2010).

4. Methodological reflections

Methodological philosophy

We write this article as a joint exercise between an academic Head of Department with a background in geography and the other a Head of Sustainability and Procurement. It is through our own work, reflections and collaborations that this paper and the methodology for carbon calculation comes about. The empirical detail we discuss is derived from own school: a large inner-London UK independent school with the objective of providing a framework which schools in the UK looking to reduce their emissions and involve students and teaching staff in the process can adapt as their starting point and can guide other schools' journeys.

In publishing this methodology, we are doing so alongside an increasing trend towards methodologies for carbon calculation across a range of sectors. For example, recent pioneering work has provided methodologies for calculating the CO2 emissions from digital data (Jackson and Hodgkinson, 2023) and, for example, recent work which calls for methodologies for carbon reporting across higher education (EAUC, 2023).

Our own philosophical position is one which resists calls for standardisation and instead advocates for methodological transparency and visibility. Standardisation risks closing debate and conversations between students and stakeholders. Whilst there are indeed commonalities between all schools such as electricity use and waste, there may be differences to account for such as the commuting of boarding students, meaning that we intend that the methodology below should be taken as a starting point for discussion and data collection across different school types and geographies.

Methodological reflections

The methodology we present below is derived by using the Greenhouse Gas Protocol (GHGP) as its starting point [https://ghgprotocol.org]. This is a multi-stakeholder partnership of businesses, non-government organisations and governments convened by the World Resources Institute (a US based NGO) and the World Business Council for Sustainable Development (a Geneva-based coalition of 170 International companies). Launched in 1998 they developed an internationally accepted greenhouse gas accounting and reporting standards for businesses and promote their broad adoption across different organisations. The GHGP initiative will be used throughout this paper as a reference document to assist in calculating carbon emissions within educational organisations.

Within the GHGP there are technical guidance documents which we have drawn on and adapted to create a methodology for Scope 2 (Sotos, 2014) and Scope 3 guidance (WBCSD and WRI, 2008) bespoke to schools. This methodology has been adapted for schools and, therefore, includes guidance for all categories that relate specifically to the secondary education sector. We developed and used this methodology at Dulwich College to create a baseline carbon footprint in 2022. However, it can be adapted to start a carbon accounting journey for all schools.

One key difference between school types (maintained/ trusts/ academies) is where information is captured and stored within each school environment; for example, a trust may operate all energy procurement centrally and information may be held within a head office. Requesting data from a central office will enable schools to understand, action and therefore make changes to their own individual campus carbon footprint. We suggest that calculating carbon footprint at the school-level rather than trust level may provide more opportunities for student involvement given children's familiarity of their own specific educational setting.

Within the methodology for calculating emissions, schools are required to look-up the emissions values of the different aspects of their operation including energy, waste disposal, transport and recycling.

- DESNZ & BEIS conversion factors are used for any data that is measured in weight, distance, volume, energy (see Department for Business Energy & Industrial Strategy, 2022). These are most likely to be useful in the calculation of Scope 1 and 2 emissions.
- DEFRA conversion factors are used for any data that is measured in currency (specifically, GBP) (see DEFRA, 2023). These are most likely to be useful in Scope 3 emissions calculations.

It is also possible to convert between the different conversion factors. For example, the cost of a given fuel could be used to estimate the number of litres – the carbon emissions of which could then be looked-up using the DESNZ & BEIS conversion factors. The conversion factors listed 'for most uses' should be sufficient for these calculations.

A well designed and maintained inventory of greenhouse gases (GHG), specifically carbon dioxide in the case of this methodology, can serve several organisational goals including:

- managing GHG risks and identifying reduction opportunities,
- public reporting and transparency,
- participating in mandatory reporting programs,
- recognition for early responsible action.

5. Calculating school carbon footprints

i) Define the recording period

When starting to review carbon emissions consider where information might already exist. Choose the period for an annual carbon review across all scopes; this may fall within a financial year or an academic year. All data collected for Scopes 1, 2 and 3 must align with the agreed reporting period.

ii) Calculating Scope 1 emissions

Gas

Create a spreadsheet for Scope 1 emissions which include Meter Point Reference Number(s)[MPRN]s from gas billing. Record the total used kilowatt hours [kWh] for each month per meter reference point. The carbon emissions can then be calculated annually for gas use in all areas. Utility brokers can also help provide this information.

Vehicles and equipment

Scope 1 also includes fuels used for actions relating to day-to-day activities and services, these may include petrol, diesel and oil. To track all fuel consumption, use invoices from suppliers.

List fuels and track litres purchased on a monthly basis. It is then possible to use the conversion factors to look up emissions.

It can help to list all vehicles which the organisation owns or leases which can then be used to calculate the emissions from fuel use. In an educational establishment this may include:

- minibuses,
- service vans,
- grounds vehicles,
- sports vehicles.

Note their engine type and fuel used. This can be cross-referenced with the conversion factor for that particular fuel to calculate the carbon emission.

Other uses of fuels may include oil-based heating or diesel or petrol fuelled power tools or grounds equipment, including leaf blowers or grass cutting equipment.

F-gas emissions are included under Scope 1: these are emissions from air conditioning leakage. F-gases are greenhouse gases which act as a coolant in air conditioning units. If any gas leaks occur from air conditioning units over the reporting year, it must be captured in the inventory by assuming the amount of gas needed to re-gas equals the amount of gas lost to leakage.

Using data already collected is the first action to start the school's carbon balance sheet. As more data is collected a clearer picture can be established; however, this method will serve as a starting point.

iii) Calculating Scope 2 emissions

For Scope 2 emissions, list the Meter Point Administration Number [MPAN]s from electricity statements or billing.

Electricity emissions are calculated on a location and market-basis. Location-based calculations use country-specific grid emission factors whilst market-based calculations use contract-specific emissions factors based on the proportion of renewable energy in the contract.

List the MPANs on a spreadsheet with meter numbers and a location description. If a utility broker is used, ask for assistance in putting this information together.

Compile kilowatt hours [kWh] data consumed for each month for each meter point.

Once there is a full 12-month history which falls into the chosen reporting period, emissions can begin to be calculated.

iv) Calculating Scope 3 emissions

Most of the information for Scope 3 will be found in a school's purchase ledger reporting. To do this, download the annual spend of a school or college for the reporting period: include invoices paid, direct debits and any other method of payment, including corporate card spend. Once this data has been compiled, it can then be manipulated to identify key suppliers and service providers. To assign the correct spend conversion factors, identify the products/ services provided by each supplier (see Table 1). To make this exercise more manageable focus on top suppliers first before becoming increasingly granular in matching specific spend to the respective conversion factor.

Note the total spend of the whole portfolio of suppliers, take any providers with an annual spend over £20,000 to analyse in year 1 to create a baseline of analysed data. Do not delete the remaining supplier spend. This will be needed to extrapolate emissions data to cover the full spend over the reporting period.

Once a list of top suppliers has been compiled, these will be the fundamental analysis that needs to be reviewed and subsequently relationships established to work on reducing emissions together, through positive engagement and communication (Tidy et al., 2016).

Some items not relevant to Scope 3 include:

- utilities which are removed as they are accounted for in Scope 1 and 2;
- fuel including fuel card bills which is accounted for in Scope 1.

Table 1 provides a non-exhaustive list for subcategorising spending:

Table 1 Suggested subcategories of school spending.

Subcategory	Scope 3 Category
IT services	Category 1
Food	Category 1
Water	Category 1 & 5
Waste	Category 5
Consumables	Category 1
Legal services	Category 1
Insurance services	Category 1
Professional services	Category 1 and 2
Pupil clothing and sports kit	Category 1 and 12
Sports equipment	Category 1

Routine maintenance	Category 1
Capital goods and site improvements	Category 2
Staff clothing and PPE	Category 1
Print services	Category 1
Copiers services or lease	Category 1
Exam board services	Category 1
Health services	Category 1
Council tax and business rates	Category 1
HR Services	Category 1
Grounds services	Category 1
Books	Category 1
Fixtures and fittings	Category 1
Professional Memberships	Category 1
Pensions	Category 1
Financial and bank charges	Category 1
Postal and courier services	Category 4

From these sub-categories, it is possible to then build a picture of the annual spend for each Scope 3 category and utilise this when calculating a baseline footprint initially using a spend-based method.

Once a baseline has been captured in year one, further investigation can be actioned year-on-year to drill down into each category by supplier to provide more accurate emissions data.

Below, we summarise emissions data by category and suggest how some improvements can be made to gather accurate information.

Category 1 - Purchased goods and services

This category includes all emissions embedded in goods and services the school purchases over the reporting year. A spend-based methodology is usually used for this category (looking-up conversion factors for each category of spending) as supplier-specific information is not usually available.

Capture all category 1 expenses as detailed in the table above broken down into:

- supplier name,
- total spend over the reporting period,
- categorisation of the product/service provided.

Professional and legal services may cover capital projects, where this is relevant the expenditure can be allocated to each category according to relevancy.

Over time, subcategories can be expanded, for example food expenditure can be calculated by food type and weight so that emissions are calculated in more granular detail.

Water billing information can be utilised to capture water used throughout a school site.

To collect water data:

- create a spreadsheet detailing all water meters and where each water meter feeds within your building's portfolio;

- track water usage by m^3 used per month.

Category 2 - Capital goods

This category covers emissions from all capital goods that have been purchased by a school over the reporting period. Capital goods are normally large, one-off investments for example and final products that have an extended life and are used to provide a service. Within the education sector, this maybe a fixed asset such as plant upgrade, the refurbishment of buildings or the upgrade of facilities or the purchase of a vehicle. Capital spend is sometimes grouped with other purchased goods and services within the purchase ledger.

Using a value-spend methodology and capturing all category 2 expenses as detailed in the table above and using conversion factors, total emissions can be calculated.

Category 3 - Fuel and energy related Activities Not included in Scope 1

This category includes emissions relating to the upstream extraction and transportation of gas and electricity. To calculate these emissions, no further work is needed. The data provided for Scope 1 and Scope 2 is also used for Category 3 using the average data method.

Category 4 – Upstream Transportation and distribution

This category includes emissions from third party transport and distribution that is paid for by the school. The data required for this category usually comes from Category 1 and emissions are calculated on a spend basis. From purchase ledger calculations, include all postage and courier costs under Category 4. This should include all spend related to moving articles or items that the school takes responsibility for sending or moving.

Category 5 – Waste Generated in Operations

Category 5 includes emissions from processing waste generated on school property. Table 2 shows categories of waste produced by schools.

Table 2 Types of waste produced by schools.

General waste [black bin bag]
Dry mixed recycling, paper, cardboard, cans, plastic bottles, and glass
Food
Green vegetation
Skip waste for bulky items
Waste Electrical and Electronic Equipment, waste for electronics and computers (WEEE)
Soft furnishing waste – this must separate from skips
Recyclable clothing
Spectacles or sunglasses
Confidential waste
Shredded paper
Chemical waste
Medical waste
Sanatory waste

	Hazardous waste
	Wrappers from sweets, crisps and snacks

To collect waste emissions, gather as much information on what leaves site as waste.

- Produce a bin container list, most waste bins are measured using how many litres of waste they hold. This can be converted to average weight per bin collected. Note how many collections are made weekly/monthly to calculate data needed to calculate overall waste off campus.
- Consult the waste management company to collate weights from all the waste your site produces. This may be recycled, waste to energy or made into other end products; for example, food waste sent for anaerobic digestion to make fertiliser.
- Specialised collections of electrical waste [WEEE], chemical waste or confidential waste should also be collected. Start to build connections with these service suppliers to identify how weight information and emissions may be gathered.

Emissions can then be calculated by each specific waste type.

Category 6 – Business travel

This category includes emissions from business travel, including staff travel for business purposes and student travel for trips. If a school has a boarding community, include their travel within this category.

Staff travel

If staff are travelling to events, shows or seminars these travel arrangements need to be logged.

If senior staff are travelling to inspections or boarder recruitment shows or development office events, all these journeys should be captured and included in Category 6. It is important to collect information on the date, start and end location of the journey and mode of transport.

Student travel for trips

If a school uses a booking system such as SOCS, utilise this system to track movements of students with accompanying staff on residential trips and excursions.

If a system-based booking record is not available, a spreadsheet should be kept with records of all journeys travelled.

The information that is required is:

- Date of travel [to enable the correct accounting year is recorded];
- Destination;
- Distance in km [this varies by air];
- Main method of transport [with class if applicable];
- Number of passengers.

Category 7 - Employee and student Commuting

This category includes the emission from employees travelling to work and student travel to school.

Table 3 Main modes of transport

Public transport
School bus
Cycle or scoot
Walk
Car
Car share
Electric car

Staff and student commuting

A student hands up survey can be taken or a full survey including student postcodes.

A more systematic approach can be used with staff. To gather commuting data, issue an online survey which requests information on: distance to travel to work, mode of transport, how often per week they travel to work.

For both staff and students create an average emission per person which can be extrapolated to include those that do not complete the survey.

Category 8 – Upstream leased assets

This category relates to anything that your school leases from a third party. The emissions associated with the use of leased assets are often included in Scope 1 and 2 emissions. For example, in a school, the printers and washing machines are sometimes leased but the energy they consume is provided by the school which would be included in Scope 2 not Scope 3. The main items to include in this category are leased properties where energy procurement is managed by the landlord as this is outside of a school's operational control.

Category 9 – Downstream transportation and distribution

This category relates to any third-party transport and distribution which is paid for by someone else. For example, a customer paying for a product to be couriered to their site. This category is not normally relevant for schools as most customers are students who are on-site when purchasing products.

Category 10 – Processing of sold products

This covers a manufacturer or industry supplier that produces parts that go on to be sold as part of another product. This category is not normally relevant for schools.

Category 11- Use of sold products

This category includes the energy used by a product that is sold by school. It is only relevant to products that consume energy or leak f-gas during use. The category is sometimes relevant to schools; for example, if laptops are sold to students, then the lifetime emissions of the laptops sold that reporting year would be included in this category.

Category 12- End of life of sold products

This category takes into account the emissions from the disposal of sold products at the end of their life. If in Category 1, items such as pupil uniform are included that are then sold to internal stakeholders, emissions relating to their disposal should be included. This category includes responsible procurement of products that can be fully recycled.

To calculate emissions the following data is required:

- Total number of products sold over the reporting period;
- The average weight of each product;
- The material type of each product e.g. plastic;
- The method of disposal e.g. landfill or recycled.

It is then possible to look-up the specific waste values to estimate the end-of-life disposal emissions.

Category 13 - Downstream leaded assets

This category takes into account the energy used in any assets that the school owns and leases out to a third party. For example, staff accommodation is included here. This category includes the Scope 1 and 2 emissions of the leased assets over the reporting period (e.g. gas and electricity) which should be calculated using the methodology for these scopes.

Category 14 – Franchises

This category relates to emissions from Scope 1 and 2 from franchises. This is not normally relevant to schools.

Category 15 – Investments

If a school makes any investments within the reporting year the emissions from the portfolio's carbon footprint for the reporting year must be included. For example, % of shares and time owned x spend factor can be used.

6. Sustainable school cultures

Whilst initial reporting may be attempted by school staff with an operational remit, it need not be an exercise which is closed to students, teachers and the broader school community who may also be able to have a say in questioning methodologies as well as using the data to inform pro-environmental actions. This approach is inspired by pioneering work in science and technology studies (STS) which frames knowledge from different stakeholders as valuable as a means to involving a multiplicity of voices and ideas and thereby opening up that which may be closed to proper scrutiny to due process and evaluation (see Lane et al., 2011). This is also in-keeping with the ethos of ESD in which actions which promote student agency are placed front and centre. There would be a disconnect if students were excluded from the process of creating and critiquing a school's carbon balance sheet if educators then expect students to show leadership in aspects of addressing climate change.

In keeping with this ethos, in November 2023 we shared our school's carbon balance sheet with a group of ten self-selected Year 12 geography students as a first step to broader engagement with this data across the school. In this workshop setting, KM facilitated discussion about each aspect of the school's emissions, including the methodology behind how emissions were recorded. Students were invited to ask questions and critique the carbon accounting methodology. Far from being unable to participate due to a lack of specific technical knowledge, students' intimate knowledge of the school site gave them a sense of confidence in highlighting areas of school where emissions might be underreported. In this way, the process of creating and refining a carbon balance sheet becomes a co-production exercise: the result of dialogue and mutual learning. The plurality of student and staff voices thus has the potential to enhance carbon reporting.

Students also used the carbon data from the baseline estimate we calculated to suggest important areas for energy reduction. For example, questioning if taps need to be supplied with hot water for washing hands. They also entered into more complex decisions about school trips and the trade-offs between how different forms of transport may be less carbon intensive but might make it harder for teachers to monitor children. Students also noted how the carbon emissions from waste are relatively low and were surprised at the amount of focus on reducing food and other forms of waste given its relatively minimal contribution to CO_2. Involving students and academic colleagues has the potential to inspire positive actions that link to student wellbeing, the broader academic and operational structures of the school and curricula across different subjects.

Figure 1 shows three axes which characterise what we suggest are core aspects of *sustainable school cultures*. The first component is that students should be able to view, explore and interrogate carbon emissions data of their own school. Similarly, we suggest a culture which embodies the open sharing of a school's carbon data to integrate this in curricula and measure the impact of collective decisions and behaviour change. There are important further deliberations to explore here around the extent to which school management would wish to publish carbon data on websites and indeed facilitating opportunities for comparison between other local schools which is likely to require cultural shifts across schools.

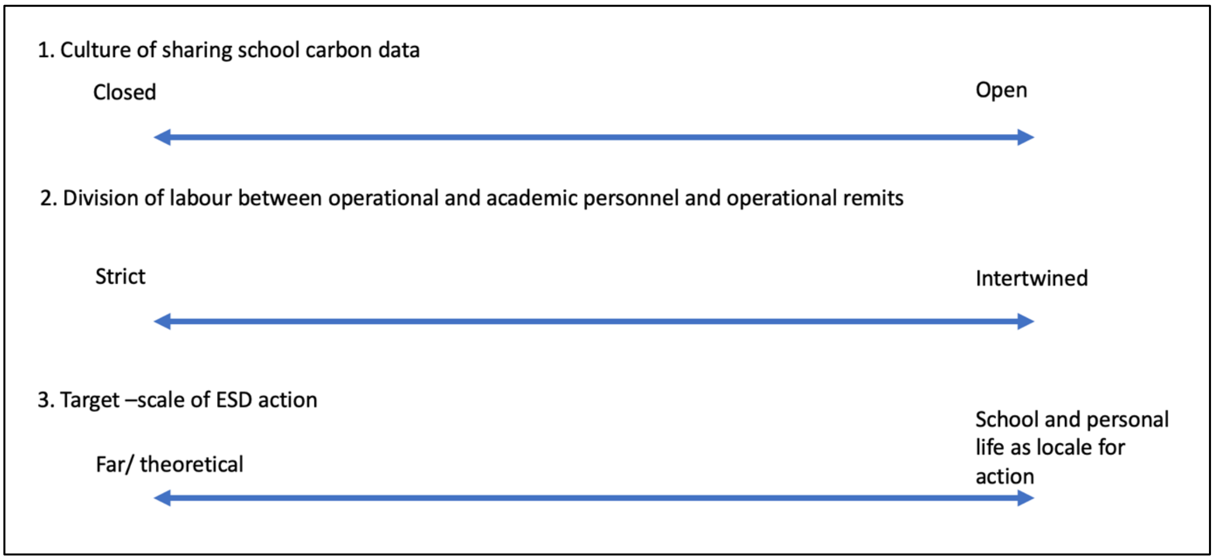

Figure 1. Dimensions of sustainable school cultures (Source: Authors)

The second aspect of *sustainable school cultures* follows in that strict divisions of labour between operational staff, who might typically be tasked with the operational implementation of net-zero strategies, and teachers responsible for academic curricula are made more fluid. As educationalist Michael Young (1993) notes the separation of knowledge from its application is reinforced through academic/ vocational divides and continues to hinder what he regards as progress towards 21st century skills. If schools are to reach net-zero it will require students applying what they have learnt in the classroom to the school site (Rap et al., 2022), changing their own behaviours – as some are already doing such as through the Eco-Schools initiative (www.eco-schools.org.uk). The third axis relates to the scale at which schools focus their attention on climate action. There is a risk that the local scale of the school and individual life is neglected as an important site from which practical pro-environmental actions can be taken.

Figure 2 shows a conceptual diagram that illustrates the reinforcing processes at play once schools embody *sustainable school cultures* that begin at level 1 in the diagram. The middle level 2 shows how measuring school carbon emissions (Scope 1, 2 and 3), can inform school curricula in which students can between understand these data and generate meaningful pro-sustainable actions that contribute to emissions reductions. It is also at level 2 where there is an on-going dialogue between students, academic and operational staff which leads to better reporting through sharing of student behaviours and ideas.

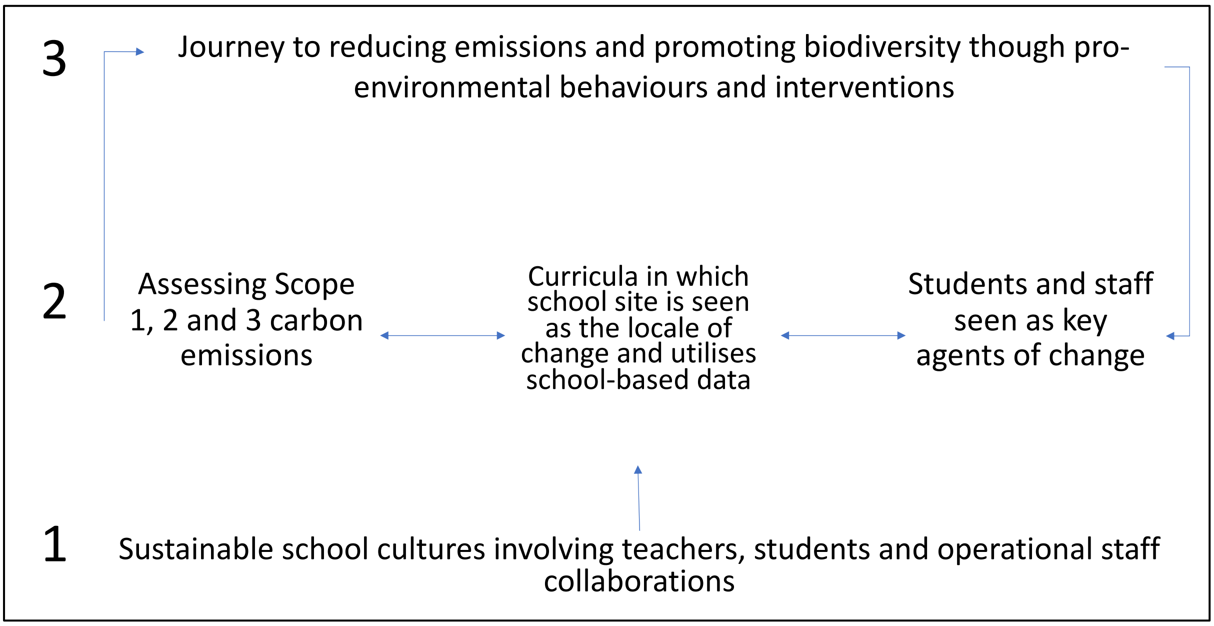

Figure 2 Conceptual diagram showing interconnection between carbon accounting, curricula and pro-environmental action (Source: Authors)

We argue that this co-construction of school carbon balance sheets can then lead to reinforcing feedbacks in which students and educational staff can take practical actions to reduce their carbon footprint and see this reflected in subsequent year's reporting. Therefore, for schools to reach net-zero we argue that it is vital that there is a methodological approach to carbon reporting, shared and critiqued by students, and then embedded into ESD, the efficacy of which is monitored through the balance sheet. Figure 2 can serve as a touchpoint to frame the important ethical and methodological considerations around net-zero which have hitherto gone underacknowledged in the academic literature and to shape fundamental questions around the ethos and school cultures necessary to reduce emissions.

7. Conclusion

This article advocates that schools' transitions to net-zero are more than a technical exercise. Not only at the level of creating school cultures in which students feel empowered to take pro-environmental actions, but importantly in the way in which there is an openness around data sharing and methodological collaboration which, we argue, enables better reporting through understanding student behaviours in school and more targeted actions which can be measured in subsequent years' carbon recordings. The technical and the cultural thus come together at the very start of the carbon accounting process.

Reaching net-zero will inevitably become more important for schools over the next few years, but there remain many unresolved areas for further research. These include how ESD curricula can be informed by school carbon data, the ways in which school operations can be changed to reduce emissions and the trade-offs this will inevitably involve, how to better allow stakeholders in school to visualise the magnitude of carbon emissions in a way in which is meaningful, how tools such as online calculators can be built which allow for participation from school stakeholders as well as comparing how schools across the different nations of the UK and internationally are approaching this challenge.

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