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ORIGINAL PAPER

Treading carefully: the environment and political participation in science education

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Abstract
Politics and science are inextricably connected, particularly in relation to the climate emergency and other environmental crises, yet science education is an often overlooked site for engaging with the political dimensions of environmental issues. This study examines how science teachers in England experience politics—specifically political participation—in relation to the environment in school science, against a background of increased obstruction in civic space. The study draws on an analysis of theoretically informed in-depth interviews with eleven science teachers about their experiences of political participation in relation to environmental issues. We find that politics enters the science classroom primarily through informal conversations initiated by students rather than planned by teachers. When planned for, the emphasis is on individual, latent–political (civic) engagement rather than manifest political participation. We argue that this is a symptom of the post-political condition and call for a more enabling environment for discussing the strengths and limitations of different forms of political participation in school science.

Keywords Environment · Politics · Teachers · Science education · Responsibility

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Introduction

In order to develop democratic environmental governance, there is a need for representation of different groups of people, opportunities for participation and for spaces for deliberation. Lidskog and Elander (2007) argue that major changes in institutions for democratic decision-making are needed when it comes to challenges posed by environmental issues. Here, we are interested in the role of schools (and specifically science classrooms) when it comes to the environment and political participation. While environmental issues are science-dependent, science is not sufficient to respond to today's environmental challenges. Tolbert and Bazzul (2020) have argued that engaging with larger systemic contexts is necessary when educating for different futures. One discipline central to any response to climate change is politics. Scholars in environmental education research including Levy and Zint (2013) have called for greater attention to political action aimed at addressing environmental issues, with Zummo et al., (2020) arguing for explicit treatment of environmental politics in education contexts.

Internationally, UNESCO (2021) has recognised that science and geography are those subjects most likely to include environmental content, and in England (the location of this study), students can expect to learn about environmental challenges including climate change, biodiversity and pollution during their compulsory science education as laid out in the curriculum published by the Department for Education (2013). Environmental topics are often controversial, rife with moral tensions and characterised by both descriptive facts and normative values. The values often deal with solutions to the problems, what kind of actions can be taken on an individual or societal level and even what kind of society is preferred. This makes the environmental issues both scientific and political.

Previous studies of materials for teaching high school science finds an absence of political considerations connected to sustainability. Scholars including Biesta (2011) and Westheimer and Kahne (2004) find a lack of democratic politics in school curricula.

In science education specifically, several studies by the authors (for example, Malmberg and Urbas, 2021) have found that a political perspective is missing in how textbooks represent environmental issues: while texts deal with causes of climate change from both an individual and societal perspective, the individual perspective is predominant when they deal with solutions. Waste sorting, travelling, and diets are recurring examples of how solitary individuals must make individual decisions. Examples with structural and political perspectives are largely non-existent. Thus as we have pointed out previously, in science education teaching resources, there is a tendency to focus on individual decision-making (Malmberg and Urbas 2019). Raveendran (2021), drawing on Ralph Levinson's (2013) work on socio-scientific issues, highlights the political nature of socio-scientific issues and the excessive tendency towards individualisation in decision-making. Although there is a place for individual responsibility in relation to the environment, a predominantly individual perspective is problematic as it:

1. Misrepresents the scale of the problem (e.g. climate change and ecological crises) and suggests that individual actions are sufficient to respond;
2. Solicits the individual as the only relevant actor for solving problems and simultaneously makes political responsibility and participation into an anomaly rather than to a part of solutions;
3. Has the potential to undermine young people's agency by denying opportunities to learn how to participate in democratic society through political processes.

Individualisation is also problematic for the learners. Essi Aarnio-Linnanvuori (2019) observes that individual perspectives can focus on ineffective activities which can provoke feelings of guilt and powerlessness. Many of the challenges facing people and communities around the world are caused by societal and political factors and are therefore in need of social and political responses. As Brülde and Sandberg (2012) note, the individual can do little, in isolation, to respond to urgent environmental challenges. Furthermore, Raveendran (2021) notes that the systems of science and technology in India specifically have overlooked the concerns of the poor and the marginalised, calling for critical scientific literacy which includes political literacy. However, this challenge to the status quo may be difficult and Tolbert and Bazzul (2020) observe that engaging with more systemic approaches may require teachers to break with institutional and social norms which do not, cannot or will not, adequately address social and ecological crises. Nevertheless, from the educational literature, Sass et al., (2020) have argued that for an individual to be described as having action competence, they must have knowledge of the democratic processes involved and be able to take a critical yet positive stance to contribute to environmental political action and Melki Slimani (2021) has highlighted the potential of environmental issues as "excellent terrain for politicisation". In this study, we wanted to understand how these calls relate to the perspectives and practices of teachers in England. To this end, our overarching research question we address is: what are science teachers' experiences of addressing political participation in school science education?

Political participation

As Julia Weiss (2020) notes, politics can be understood in different ways, from a narrow focus on electoral processes to broader conceptualisations which include different ways of making decisions and shaping power relations. Some, such as Jan van Deth (2021) have argued that the expansion of different ways of participating in democratic societies has rendered a single definition of political participation obsolete, focusing instead on a method for determining whether any activity can be considered political based on a series of questions about its locus (polity), targeting (of government area or community problems), and the circumstances (context or motivations) of the activity. In this study, we are concerned with politics as Colin Hay (2007) puts it: "the capacity for agency and deliberation in situations of genuine collective or social choice" (p. 77). This definition of politics goes beyond electoral and party politics and includes activities outside formal political institutions. This is consistent with Andrew Heywood's (1999) characterisation of politics as a social activity that arises out of interaction between or among people, which develops out of diversity (the existence of different interests, wants, needs and goals), and which relates to collective decisions which are regarded as binding upon a group of people.

This characterisation of politics is relevant to our study context as education is a social activity which brings together people with different views, interests, wants and needs in relation to the environment, and it is a context in which collective decisions can be made. Ekman and Amnå (2012) have developed a typology of different forms of participation in politics. They distinguish between (a) non-participation (disengagement); (b) civic participation (latent political), whether social involvement or civic engagement; and (c) political participation (manifest political), which can be formal political participation or activism (extra-parliamentary political participation, with legal or illegal forms). Non-participation, civil participation and political participation are classified as individual or collective

forms. The typology is reproduced in Table 1. We use this typology as a framework. While other frameworks such as that developed by Slimania et al., (2021) exist for integrating the political dimension in environmental education, these are concerned with integrating the thematic content of environmental issues with political learning (of ecoliteracy, citizenship, deliberation and in collective action regimes) and educational purpose to explain the politicisation of environmental education. We were motivated to make multiple forms of political participation tangible to teachers, in order to understand their experiences of politics when teaching environmental issues in school science. We therefore used Ekman and Amnå's (2012) typology to frame the study as this enabled us to connect concrete forms of political participation to environmental issues and make different types of political action visible in discussions about school science.

Environment, politics and science education in England

According to research on education policy in England, Melissa Glackin and Heather King have reported a general absence of environment education policy, and where it exists, learning is *about* rather than *for* the environment (Glackin and King, 2020). Environment and climate change education tends to take place in Science and Geography lessons, and there constitutes a very small part of the curriculum. In 2022, the government Department for Education launched a sustainability and climate change strategy for education which aspires to put climate change at the 'heart of education' (Department for Education, 2021). Analysis of this strategy found an absence of governmental responsibility and of attention to the political dimensions of climate change, with science reinforced as the key school subject responsible for climate change and sustainability education (Dunlop and Rushton, 2022). The absences can be considered depoliticising, described by Flinders and Buller (2006) as where those in power "move to an indirect governing relationship and/or seek to persuade the demos that they can no longer be reasonably held responsible for a certain issue, policy field or specific decision" (p.295–296). The strategy attempts to shift responsibility to the education sector without creating an enabling environment for schools and teachers to act, presenting the problem as one that can be addressed with more (scientific) facts and individual actions (Dunlop and Rushton, 2022). Yet this is inconsistent with calls from international bodies such as the OECD (2022) which argues: "educating for the environment needs to not just equip young people with the decision-making skills to navigate through life but empower and support them to take action" (p.3).

Also associated with depoliticisation is the government's statement on political impartiality (Department for Education, 2022) which does not define what constitutes a political issue or political activity, whilst simultaneously stating that teachers should not encourage pupils to engage in a specific political activity. Whilst discussing a position is not the same as promoting a position, there is a possibility of misinterpretation or misrepresentation which renders discussing controversial issues—such as responses to the climate crisis—as risky.

There are at least two consequences of depoliticisation: anti-politics and post-politics conditions. Wood (2016) argues that anti-politics can be thought of as attitudes that are generally against how politics works and where political participation is discouraged. In contrast, post-politics, according to Johnstone (2014) is the condition in which a consensual policy framework built on neoliberal principles sits outside democratic processes. Both anti-politics and post-politics distance people from involvement in decision-making

Table 1 From Ekman and Amnå (2012). Typology of different forms of disengagement, involvement, civic engagement and political participation

	Non-participation (disengagement)		Civil participation (latent political engagement)		Political participation (manifest engagement)		
	Active forms	Passive forms	Social involvement	Civic engagement	Formal political participation	Legal extra-parliamentary actions	Illegal actions
Individual forms	Perceiving politics negatively	Non-voting	Taking an interest in politics and society, and perceiving it as important	Writing to an editor	Voting in elections and referenda	Boycotting, boycotting and political consumption	Civil disobedience
	Avoiding reading and talking about politics	Perceiving politics as uninteresting and unimportant		Donating to charity			Politically motivated attacks on property
				Discussing political issues	Contacting political representatives or civil servants	Signing petitions	
				Recycling	Running for or holding public office	Handing out political leaflets	
Collective forms	Deliberate non-political lifestyles such as hedonism or consumerism	Incidental non-political lifestyles	Belonging to a group with a societal focus	Volunteering in social, charity or faith-based community work	Being a member of a political party or a trade union	Involvement in new social movements or forums	Civil disobedience actions
	Riots reflecting alienation or social exclusion		Lifestyle related involvement e.g. veganism	Activity within community-based organisations	Activity within a party, an organisation or a trade union (voluntary work or attend meetings)	Protesting/striking	Sabotaging or obstructing roads and railways
							Violent confrontations with police

processes and thereby reduce their capacity to influence living conditions. This is a concern for environmental politics as young people of school age are generally unable to participate in electoral politics and to influence responses to environmental crises.

The recent *Politics in Schools* project led by Weinberg (2020) surveyed teachers and students in the UK (mainly England) and found that political education is peripheral in many schools, with some students unlikely to experience comprehensive (or even piecemeal) political education, even though the vast majority of teachers felt some level of subjective responsibility for political education. Slimani (2021) found teachers supportive of an action-based climate change curriculum which includes issues of global social justice. This matters, because the more political education students had, the more positive their attitudes towards participatory behaviours (Weinberg, 2020), that is to say: education informs action. Weinberg also found that the quality of experience was important, with participatory approaches which explore social and political issues through interactive and discursive pedagogies promoting more positive attitudes to political participation. This suggests both *what* is taught and *how* it is taught are important indicators of political participation. David Kerr (2000) notes that whilst political education can be confined to citizenship classes, there is a potential place for teaching *through* and *for* citizenship in other school subjects such as science, particularly on environmental themes which may feature in science only. Although few studies focus explicitly on science teachers' perspectives of addressing politics in the science classroom, a recent site-specific study looking at how schools dealt with the prospect of fracking in their local community found that science teachers were reluctant to deal with it as a political issue, and even saw science as apolitical (Dunlop et al., 2021). In the present study, we seek to explore science teachers' experiences of addressing politics in school science education in relation to environmental issues.

Methods

Research design

An exploratory qualitative approach was used to understand science teachers' experiences of teaching the political aspects of environmental issues. A deductive content analysis was selected to enable an in-depth exploration of teachers' experiences of political participation in science education in relation to the forms of participation in politics identified in Ekman and Amnå's typology. We focused on teachers with responsibility for teaching students aged 11–16 in England because we were interested in what students experience during their compulsory secondary science education, where the curriculum demands that they learn about ecosystems and the environment. A deductive approach to instrument design was used, drawing on Ekman and Amnå's (2012) typology of latent and manifest political participation and non-participation (see Table 1 above) in the design of the interview guide and in the analysis of data.

Participants

A purposive approach was used to invite science teachers within existing professional networks to participate. In common with other qualitative studies (e.g. by Smith and Osborn, 2004), a small number of participants was selected in order to conduct detailed analysis of each teacher interview in order to produce a detailed account rather than reach

generalizable conclusions for all teachers. The sample included eleven science teachers from eleven different schools, with different levels of interest and experience in environmental education. Malterud et al., (2016) have argued that where the study aim is narrow, participants are specific for the study aim, the study is theoretically informed, and interview dialogue is strong (as we argue is the case in the present study), a very small sample size can have sufficient information power to answer research questions in an exploratory study.

Teachers are described briefly in Table 2, using pseudonyms to protect identities. Teachers' experience varied from 2 to 25 years, in different roles including those with responsibility for the curriculum, subject, examinations or a key stage. One teacher had an undergraduate degree in a non-science subject and two teachers had international teaching experience.

Procedures

Ethical approval was obtained from the institutional ethics committee. Given the potentially sensitive nature of some of the questions, we used one-to-one online interviews. A semi-structured interview guide was designed by the research team and piloted with two science teachers (not included in the final analysis). Each interview began by reminding participants of limits to confidentiality relating to any disclosures of illegal activities. The interview guide contained open-ended questions on science teachers' perspectives on and experiences of teaching environmental politics in science education.

Participants were provided with an infographic using examples from Ekman and Amnå's (2012) typology (Fig. 1) and asked to mark ways of participating in society which they had:

1. Planned and taught (green);
2. Mentioned in passing or in response to a question from a student (orange); and
3. Never addressed (red).

The interview focused on reasons for these decisions. Interviews were conducted by three members of the research team and took place in January—June 2022. Each lasted approximately 1 h.

Table 2 Participant description

Pseudonym	Teacher details
Emerson	Male chemistry specialist, state school, > 15 years
Juliet	Female science teacher, state school, > 5 years
Robert	Male physics specialist, independent school, > 5 years
Steven	Male chemistry specialist, independent school > 5 years
Dennis	Male biology specialist, state school, > 20 years
Peter	Male biology specialist, state school, > 20 years
Rose	Female chemistry specialist, state school, < 5 years
Jenny	Female science teacher state school, > 15 years
Steph	Female biology specialist, state school, < 5 years
Matthew	Male chemistry specialist, state school, > 5 years
Madison	Female biology specialist, state school, < 5 years

Fig. 1 Examples of disengagement, civic engagement and political engagement drawn from Ekman and Amnå's (2012) typology

Methods of analysis

Interviews were recorded and transcribed qualitative content analysis was used to analyse the data. We followed the three phases of preparation, organising (developing the typology for participation in politics previously described for coding) and production of categories described by Elo and Kyngäs (2008) in the analysis. An iterative approach to data analysis was used, with reflexive discussions between each stage of analysis. The stages in analysis were.

1. All researchers familiarised themselves with the data by reading transcripts and making open notes.
2. Initial impressions and emerging themes were discussed in a series of online meetings.
3. Emerging keywords and themes were assigned to each teacher's transcript.
4. Transcripts were deductively coded by all researchers using Ekman and Amnå's (2012) typology of political participation and civic engagement as a framework in order to compare the findings for each form of participation across all transcripts.
5. In a series of face to face team meetings, we looked for patterns (similarities and differences) in responses across different forms of latent and manifest political participation, from civic engagement, to formal political participation and legal and illegal activism (extra-parliamentary participation).
6. We created a table (Table 3) to represent the best fit as to whether teachers planned and taught, responded to or avoided different forms of latent and manifest political participation. Where cells are blank, this indicates that no activity fell in this category.
7. In the final stage of analysis, we discussed the ways in which science teachers experienced the environment and politics in the classroom and what it means for them. Here, we identified ways in which environmental issues were politicised or depoliticised, drawing on the definitions outlined before by Flinders and Buller (2006) and Hay (2007) in the science classroom and then returned to the transcripts to understand the mechanisms by which these processes happen.

As small-scale study with voluntary participants, we neither aim for nor claim generalisability beyond the sample. Instead, we have focused on the construction of a narrative based on a close analytic reading of teachers' experiences, attending to similarities and differences across the teachers in order to understand how political participation enters school science. To help ensure a range of perspectives were represented, we attempted to include science teachers with diverse views by inviting teachers from different school types and broad professional networks rather than from environmental education networks.

Results

Science teachers' perspectives on political participation were analysed using Ekman and Amnå's typology, distinguishing latent and manifest political participation, and individual and collective forms of participating in society. There is little perceived distinction between *talking about* and *promoting* political issues, for example, there was at times conflation between talking about protest and encouraging pupils to participate in protests.

Science teachers see a purpose for teaching political participation in school science

The teachers we spoke to held different views on the role of politics in science education. Talking about political participation was seen as a right by some teachers, and specifically in science, although party politics was off the table:

> …young people have got a right to engage with the world around them…they should have the right to be able to discuss [fossil fuels, renewables and energy use and costs in the home] and to have their say in a constructive manner…we need to teach them

Table 3 What teachers plan for, respond to and avoid in relation to environmental politics in the science class

	Civil participation (latent political)		Political participation (manifest)	
	Individual	Collective	Individual	Collective
Teachers plan for	Writing to an editor		Voting in elections and referenda	
	Giving money to charity		Contacting political representatives or civil servants	
	Engaging with media			
	Recycling			
Teachers respond to students' comments and questions	Discussing politics and societal issues, with friends or on the internet	Volunteering in social work	Buycotting and political consumption	Involvement in new social movements or forums
		Charity work or faith-based community work	Signing petitions	Protesting/striking
		Activity within community-based organisations		
		Belonging to a group with societal focus		
		Political lifestyle		
Teachers avoid			Running for or holding public office	Handing out political leaflets
			Donating to political parties	Civil disobedience
			Being a member of a political party or a trade union	Violent action
			Activity within a party, an organisation or a trade union (voluntary work or attend meetings)	

Actions were assigned the 'best' fit category, and there are exceptions, which are discussed in the findings

how to use their voice properly and how to be heard. *Steph*

If they can understand the system and how it works and all of its failings and how other organisations can influence it at a scale bigger than them they have to sort of like know that they can actually influence it, like Greta Thunberg, that they can effect change at a local level. *Dennis*

Others were more concerned about the relationship between politics and scientific knowledge, with some seeing politics as distracting and others seeing it as a way to bring knowledge to life:

I don't like to see politics in the classroom for science, because I almost find it to a point a distraction from the explicit science that we are trying to get across and the application of that science. *Jenny*

If you just give them the facts, I don't think they are gonna be able to be politically active now because they have to connect the facts…greenhouse gases, how are we producing them, is it the…cows on the farms, what can we do about it? So, we give them the facts, they connect that with these ideas, and hopefully they can make those decisions. *Emerson*

Several science teachers discussed their reluctance to discuss politics where it challenged students' lifestyles, for example agriculture, long distance flights to international schools or diets. Even when teachers supported teaching different forms of political participation, it was often acceptable only within certain limits in school science. Where family members had been affected by an issue, teachers tended to shy away to avoid accusations of insensitivity. Teachers also discussed potential safeguarding risks of teaching political participation. Perceptions of some teachers and students were also a barrier to engaging with environmental politics in the science classroom:

It will annoy physics teachers and students who want to do medicine. *Peter*

No teachers saw the value in non-participation (disengagement) and when it came up, they described talking to pupils about their responsibility to vote, and about non-voting as being 'pointless' or a 'terrible idea'.

Political participation is almost absent in science lessons

Despite the desire to teach about political participation in science lessons, this was relatively rarely experienced. Table 3 synthesises teachers' responses to what they would plan for, respond to and avoid in their lessons. Whilst many forms of political participation are actively avoided or addressed in response to students' questions, relatively few are planned for.

Literacy was identified as a barrier to writing to representatives. Socio-economic background of students was a barrier to talking about donating money to charity, and teaching large numbers of international students was a barrier to talking about some lifestyles (e.g. those involving air travel). Most teachers were happy to discuss voting, with several describing examples of planning in other subjects as well as in science:

Voting: yes, we definitely do it in a Science context because when we talk about stuff like, "What can we be doing to help with the environment and climate change?" and if certain parties or people that don't have a pretty strong scientific understanding it's like, "Well, how do you get rid of them? You vote someone else in". *Matthew*

Constraints on talking about voting related to the party politics:

> I need to be very aware of my responsibilities not to promote my own personal beliefs. So I will stay far away from saying… well I would never discuss who I voted for. *Steven*

Not only does Steven never discuss which party he votes for but he also believes that he has a responsibility not to present his own position on other issues, a view expressed by other teachers.

Juliet expressed concern about this absence:

> Discussions in classrooms are vanishing... I just don't think students feel like they can challenge authorities. I think they wouldn't be confident to take collective action… And a lot of them are angry and you would feel like they would want to mobilise against some things that really affect them, but I don't think they would know how.

Teachers had greater experience teaching individual forms of participation than collective forms

Individual forms of participation (recycling, media engagement) were planned for and taught. Teachers described being more comfortable with these because these activities were more passive and information-seeking, and young people can decide for themselves. When it comes to manifest political participation, teachers tended to report that they were happy to create opportunities for students to sign petitions because it was an individual decision:

> we've had climate petitions in school, we've been encouraging signatures on those…. the ownership is more on them, to say no I am not signing this.' *Matthew*

However, some individual forms of manifest participation were positioned as risky by teachers following a case where the Secretary of State for Education had condemned schools for allowing students to criticise the prime minister (in relation to parties held during the pandemic and later lied about) in class.

> …the Secretary of [State for] Education…thought that was not a good thing 'cause he said this school is basically teaching the kids politics and probably pushing them towards the party who had signed, or something like that. *Emerson*

Little was said in relation to discussing politics, although one teacher noted:

> I think I would be a bit wary about discussing politics online…I would just be worried that the students might encounter extremist views, extremist organisations and be sucked down that alley…*Madison*

Whilst giving money to charity was commonly addressed by teachers, teachers in schools with a high proportion of students from economically disadvantaged backgrounds reported this as something they would avoid.

Planned teaching about collective activity such as volunteering, doing charity work or belonging to organisations or trade unions was less common and often only encountered in a response to students' questions or comments. Some teachers lacked knowledge of groups:

> To be honest, I don't really know of any! So, I wouldn't be able to suggest any! *Madison*

Others had been told not to talk about certain groups, including Extinction Rebellion. More often, reluctance to teach about collective forms of participating in society were linked to safeguarding concerns, for example:

> I actually do get quite worried about that because I feel like some of the students I teach, I basically don't know what they would do outside... I do feel like it could come back to me if I was kind of advocating to go and be disobedient and it kind of got out of control. *Juliet*

Teachers discussed experiences of vetting groups and checking what their school permitted, and shared different ways of talking about groups, most commonly as providers of information on environmental issues or making students aware that there were groups they could join, rather than promoting or advocating joining specific groups.

Resistance to some collective school actions was reported. For example one teacher suggested offering a vegetarian school meal once a week, which they felt was seen by colleagues to go against the 'values of the country' (*Juliet*).

Civil (latent political) participation was experienced more often than manifest political participation in science lessons

When contemplating engaging with political activity, teachers tended to report steering away from manifest political participation, while civil participation was described as more palatable.

Teachers identified constraints on some forms of civil participation such as teaching about joining a group with a societal focus. They tended to vet groups with the school, particularly in terms of working with children and safeguarding. They were happy to discuss national charities such as Greenpeace, Oxfam, People and Planet, whereas there were reservations about teaching about non-violent direct action groups such as Extinction Rebellion and Insulate Britain.

Teachers reported avoiding party politics, including running for office because it was seen to be 'for the adults' (*Emerson*), they don't know how to run for office (*Juliet*), or could be seen as partisan (*Steph*):

> I wouldn't actually be able to say this is what a Tory would think, this is what the Labour Party thinks, this is what the Green Party thinks, without completely anonymising it and taking that label away. There's certain restrictions there.

Some were happy to talk about party politics in a more general sense, but not to express their own allegiances, or to attribute positions on issues to specific parties.

Whilst no form of civil participation was avoided, many forms of manifest political participation were, and described as 'a bit much' (*Emerson*) or 'a step too beyond what we discuss in school' (*Matthew*). This sometimes came into conflict with their personal beliefs:

> I think they should [join political parties] but I wouldn't bring it up. *Rose*

Some teachers reported that they would discuss civil disobedience:

> I'm not suggesting that I would advocate civil disobedience to my students but…. glueing yourself to a motorway because you think that it's important to insulate Brit-

ain…might come up as an issue and it might prompt a discussion that is relevant to something to do with science. *Peter*

Other teachers expressed experiences of worry and fear (*Juliet*) about discussing civil disobedience, did not want 'people getting wound up' (*Matthew*) or "a discussion on the dinner table where it comes back to… they say, 'this is what we learnt in school.'" (*Emerson*).

Even when political participation is present, students rather than teachers bring politics into the classroom

While many of the teachers claimed that they would not actively avoid teaching about political participation, they do not plan for its teaching. They do, however, mostly feel able to respond to issues their students bring into the classroom.

It's not something that we plan for but if it was something that needed to be talked about like how you can get involved I would certainly feel able to do that. *Matthew*, in reference to boycotting and striking.

Similarly, Dennis describes how students brought politics into conversations about climate change:

one of these kids says…if you're going to effect change there's no point going for politicians because they're going for the populist vote … and they get funded by industry so they're hugely biassed. You can't go for industry because they've already got their financial base so what you actually need to do is…have a grassroot youth movement that says we reject what you're offering... And as soon as they get the impetus behind that and start to get a following then industry will then start to follow with the money to capitalise and then the politicians will follow last and I thought that was such a refreshing and ingenious way of looking at the problem is don't wait to be told it's okay just do it. *Dennis*

Table 3 shows the forms of participation where teachers said they would respond to students' comments and questions (but not plan to address).

This pattern, where experiences were shaped by student interests and questions, was observed across all participants.

When teachers bring political participation into the science classroom, it is linked to the curriculum

Recycling was planned for by all teachers as it features in the curriculum and was often a school activity that could involve students. Other forms of participation did not feature in the curriculum, which made it difficult for some teachers to address politics in the classroom.

I think a lot of these things are important but apart from the recycling one they are largely peripheral to my curriculum. *Peter*

there's a danger that that's in the back of my head all the time, thinking I can't really stray too much from the course content….somewhere along the road I've obviously picked up the idea that my job is not primarily to determine what should be taught but just how to teach it. *Robert*

Beyond the curriculum the frameworks that surround teachers and their legal duties to political impartiality:

> We've also got to respect the professional and legal position that we are in…there's specific governance that tells us we can't talk about party politics" (*Steph*)

Teacher impartiality and school policy also influenced discussion around civil participation, significantly protesting and striking.

> I believe it's important and I think it's a way of showing kind of en masse what you believe…I feel like I have to take the school line…so I really wouldn't encourage students to miss school to attend a protest, if I'm really honest." (*Juliet*)

School policies and teacher responsibilities were also referenced in relation to some elements of engaging with media.

> We wouldn't necessarily say you need to go out on Twitter and look at this hashtag and follow it through, because it's just opening the rabbit holes, and it might not be a safe thing to recommend to the kids either. It's a safeguarding risk. (*Steph*)

Teachers also noted that there were few opportunities to have conversations with colleagues about how to respond to environmental politics in the classroom, which they felt diminished their capacity to address related questions.

Legal forms of political participation are more present than illegal forms of political participation

Perhaps unsurprisingly given the risks identified, and teachers' fear of discussing being seen as endorsement or advocacy, few teachers described talking about violent action. As Jenny describes:

> Maybe unconsciously talking about it is a silent reinforcement of violent action and it is something that I would say in the pit of my soul I am a pacifist! And, it is maybe possibly related to that!

Where teachers did discuss violent action—only one in a science lesson—it was in response to a news feature. For example, Dennis discusses the tactics of an environmental direct action organisation:

> they serve a phenomenally important purpose in society because they keep the issues in the frontlines that people keep going, oh god, it's them again, what are they banging on about this time?

One teacher said that if violent action came up in a discussion with a student, that they would 'pass that information on' (*Peter*). Others noted the importance of avoiding violence in language as well as in actions:

> ..if we get comments that are turning negative or derogatory in any way, then we need to teach them how to use their voice properly and how to be heard, so we don't get these negative connotations for youth protests as in troublemakers. *Steph*

Discussion

The aim of the study was to find out in what ways science teachers address political participation when teaching environmental issues. In this section, we discuss our findings in relation to the research questions and extant literature.

Although not a view held by all teachers in the study, most tended to believe that political participation in relation to environmental issues should feature in science classrooms. This was put forward as pupils' right to be engaged and use their own voice and to experience politics and understand the political system. The flipside was politics seen as a distraction from the core content of science, and a risky one at that. Even when science teachers are in favour of young people learning politics, opportunities do not tend to be planned to teach how to participate in society. Politics enters the science classroom primarily through students rather than teachers. Conversations on political participation tended to be ad hoc, unplanned, and not accessible to all, with some ways of participating in society avoided. Teachers reported that they avoided critique of some practices specific to the student body (e.g. long distance flights in independent schools, eating meat in rural schools) to prevent conflict with students, parents and school leaders. Only those forms of participating explicitly stated in the science curriculum were planned for and taught.

Lack of planned opportunities for young people to learn about politics, and about how to have agency in situations where there is a collective or social choice to be made (Hay, 2007) is problematic—even in science lessons—for three main reasons. Firstly, as Rousell et al., (2019) found in their systematic review of climate change education, facts are not sufficient to bring about actions or change. Secondly, as UNESCO (2021) and Jorgeneon et al., (2019) have noted, individual actions are a misdirection of attention from the collective and systemic change needed to deal with environmental crises. Finally, young people need to learn not only how decisions are made, but how to work across differences. Robert Talisse (2021) argues that polarisation, whether in politics or in beliefs, erodes democratic capacities, and Chloe Lucas (2018) points out that this is a particular problem in relation to climate change. There is a need for educational spaces for discussion and disagreement to support young people to understand perspectives they disagree with and be a part of collective responses to local and global environmental threats. The United Nations (2012) notes that education has a key role to play in challenging unsustainable lifestyles and the systems and structures that bring these about, and this demands attention to politics—how decisions are made and how they can be influenced.

Responsibility for teaching politics in relation to environmental issues lies in part with science teachers, but perhaps more significantly with leaders and policymakers who set the bounds on what is acceptable in classrooms. Talking about some forms of political participation is seen as risky, with teachers fearing that discussion could be interpreted as advocacy. We found teachers silenced and self-censoring, treading carefully to avoid 'landing in hot water.' Barriers were associated with policy (political impartiality, teachers' standards, curriculum), assessment and league tables, parents and academy trust leads, as well as perceived student and colleague responses. If science is to be the subject where young people in England learn about climate change and other environmental issues, there is a need to create conditions to deal with the political dimensions of these. This points to the need for school leaders and policymakers to give teachers licence to teach for political participation and to suggest models

for distinguishing between teaching and promotion. It has been argued (by Biesta and Lawy, in 2006) that learning democracy involves understanding democracy as a process rather than an outcome and recognising that education can influence the social, economic and cultural situation.

In common with studies in other European contexts such as Aarnio-Linnanvuori (2019) and Malmberg and Urbas (2021) we found a focus on the individual rather than the collective. We also found a focus on civil (latent political) participation rather than manifest political participation. Teachers feel able to bring in individual methods of participating in politics, but are prevented (by confidence, policy, safeguarding concerns, accountability to parents, concern to not challenge lifestyles) from bringing more collective and manifest forms of participation into the science classroom. Similarly, Aarnio-Linnanvuori (2019) found that teachers in Finland tended to describe their students' possibilities for action as more limited than adults with active citizenship and significant private sphere actions as out of reach for younger students. This is not to say that we advocate encouraging students to take specific actions, but rather creating space to discuss the strengths and limitations of different ways of participating in society.

In response to the question 'What kind of citizens do we need to support an effective democratic society?', Westheimer and Kahne (2004. p.239) have created a typology with three categories; the personally responsible citizen; the participating citizen; and the justice-oriented citizen. The personally responsible citizen is the category most evident amongst the participating teachers. Van Poeck and Vandenabeele (2012) argue that schools have a citizen-forming function in relation to sustainability. They describe two functions: 'citizenship-as-achievement', which gives students the opportunity to acquire knowledge that they can use later in life; and 'citizenship-as-participation' where students already here and now, are allowed to take a stand on issues of sustainability. We do not find much evidence of citizenship-as-participation being promoted amongst our participants.

In common with Weinberg and Flinders (2018), teachers' political conceptions of citizenship tend to align with an individualised vision. Politics itself is depoliticised by being removed from the public (educational) sphere as a topic rarely up for discussion—and only in certain ways and under certain circumstances. This is in line with how Chantal Mouffe (2005, 2013, 2018) sees contemporary political rationality putting individual choices before collective solutions. This post-political rationality is observed in the field of education and sustainability, for example by Håkansson et al. (2019), who reviewed literature on education for sustainable development. Phil Johnstone (2014) argues that this places a consensual policy framework built on neoliberal principles outside democratic processes. In this way—even in the school science classroom, post-politics distances people from involvement in decision-making processes and thereby reduces their capacity to influence living conditions. This is a concern in the context of environmental politics as young people of school age are generally unable to participate in electoral politics and to influence responses to environmental crises.

Politics (especially collective political participation) is experienced as off-limits to teachers in the study. This post-political logic potentially distances people (here, young people but also teachers) from involvement in decision-making and reduces their capacity to be involved in environmental decision-making now and in the future. These absences, we argue, contribute to a broader societal trend which closes off spaces to discuss and celebrate disagreement and which diminishes the potential for young people to learn democracy, and to take part in decisions about how to transform societies in response to climate change, whether through adaptation, mitigation or other responses. In order to develop

democratic governance of environmental issues, there is a need for representation, opportunities for participation, and for spaces for deliberation.

Conclusions

The novel application of Ekman and Amnå's typology to school science education enabled us to understand how teachers experience politics in school science when they are teaching about the environment. Whilst teachers participating in this study saw a purpose for teaching environmental politics in science education, it was described as almost absent in lessons. Science teachers in the study were more likely to have experiences of discussing individual, legal, forms of participation, focusing on civil (latent political) actions rather than collective, manifest forms of participating. Students rather than teachers introduced politics, unless there were links to the curriculum or other legal and political frameworks. Policy (national and school) and colleague and student perceptions prevented science teachers from planning to discuss manifest forms of political participation with students.

Schools are in many ways ideal sites to encourage political participation as they are shared spaces of learning—both about forms of participation but also how to participate and to deliberate across disagreement, or as one of the teachers in this study put it 'we need to teach them how to use their voice properly and how to be heard'. This is a proposal for dialogic interaction, where different perspectives can be put forward and, at the same time, generate learning. In a dialogic classroom, methods are used so that the students' individual opinions are allowed to emerge and that pupils thus have the opportunity to deal with value conflicts and argue for their positions. The political theorist Chantal Mouffe (2013) claims that conflicts are inevitable. She uses the concept of agonism to show that conflicts do not have to become antagonistic, that is, when we see each other as enemies. Teachers can also create situations where students can enter other people's worlds of values, for example through role-playing, what the humanist Martha Nussbaum calls the narrative imagination (2010) and which involves the ability to think what it might be like to be in the shoes of a person different from oneself.

As the window of opportunity for securing a livable and sustainable future for all closes (IPCC, 2022), and no apparent changes to the national curriculum in England have been proposed in recent policy on sustainability and climate change in the education system (Department for Education, 2022), what role can science teachers play in supporting young people to participate in politics? Recognising the experiences of science teachers in this study, we make two concrete recommendations for further action in relation to classroom pedagogy and teacher development.

The first aims to encourage students to think about how decisions about science and the environment are made in order to raise what Paulo Freire (1974) describes as critical consciousness, i.e. the ability to engage in reflection and action upon the world in order to transform it. We propose the use of critical questions to encourage students to think about the social and political context of environmental science. For example, asking 'how are decisions about X made?', 'how is X regulated?' or 'how could you make your views on X heard by people with authority to take action?' and 'what are the limitations of how decisions are made about X?' and 'how are decision-making processes changed?' prompts both students and teachers to think about existing political systems, and how they might intervene in processes in a way that is non-partisan, does not promote specific actions, and suggests to students what they might think about (rather than different positions they might take).

The second approach is the use of case studies in environmental politics in education. These might be used to prompt discussion about environmental issues by groups of teachers in a school, or by teacher educators with beginning teachers in a university or school. The explicit links to politics in these examples enables teachers to discuss science education in its broader context, and what this means for the teaching of environmental issues. These discussions can also support the creation of a sense of collective identity which can support action against obstructive educational regimes.

The first example of a case study is as follows, focusing on 'extreme political stances', drawing on recent policy in England.

> You are teaching in a state school in England and receive new guidance from the Department for Education: "Schools should not under any circumstances use resources produced by organisations that take extreme political stances on matters. This is the case even if the material itself is not extreme, as the use of it could imply endorsement or support of the organisation. Examples of extreme political stances include, but are not limited to, a publicly stated desire to abolish or overthrow capitalism"

- How do you define an extreme political stance in relation to the environment? Why?
- How would you decide which organisations' materials you can use? Oxfam, Greenpeace, Friends of the Earth, BP, Shell, Extinction Rebellion?
- What are the consequences of airing or silencing 'extreme' environmental stances in educational settings?
- Is an explanation of the connections between capitalism and climate change an example of an extreme political stance?
- What is the difference between *discussing* environmental activism and *promoting* environmental activism in a science classroom?
- What can be learnt from how teachers of other subjects tackle issues that have brought about social change (e.g. the history of women's suffrage or of the trade union movement)?

The second example relates to the place of politics in school science:

> A science teacher decides to spend half of a lesson talking about the recent COP negotiations as a way to demonstrate the relationship between science, economy, the environment and society, and to make chemistry more relevant. The teacher includes material beyond that stated in the examination specification. A student challenges the teacher's use of time with the question 'why are we learning about this if it is not on the curriculum and we are not going to be assessed on it? I don't need to know this to get into medical school.'

- What should the teacher do or say?
- What are the possible consequences of the teacher's decision?

Use of the critical questions and case studies above has the potential to re-politicise the issue, i.e. to bring the discussion of environment, politics and education into the private and public spheres. Whilst these suggestions do not alter the neoliberal landscape in which teachers are operating, they present opportunities to identify and challenge the structural barriers to educating for democracy, taking into account the strengths and limitations of

the many forms of political participation possible in response to the climate crisis, which opens the narrative imagination of teachers and young people to alternative realities through which to tackle the climate emergency.

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Declarations

Competing interests The authors declare no competing interests.

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