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Reconceptualising Preservice Teachers' Subject Knowledge in Climate Change and Sustainability Education: A Framework for Initial Teacher Education from England, UK

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Abstract: Climate Change and Sustainability Education (CCSE) has been gaining prominence with the imminent climate emergency humanity is facing. This paper draws upon a conceptual framework created to support the development of preservice teachers' subject knowledge of CCSE whilst undertaking Initial Teacher Education (ITE) programs in England. The core aims and learning outcomes within the framework, namely knowledge; attitudes, values and behaviours; and competences and capabilities, are defined to illustrate what subject knowledge looks like, in this area, for preservice teachers in England. This paper highlights data gathered from 71 preservice teachers via an initial presurvey from three ITE institutions across England. The data were gathered from Early Years and Primary and Secondary phase trainees across both postgraduate and undergraduate programmes. The presurvey captured a range of qualitative and quantitative responses from preservice teachers to showcase priority areas, from their perspective, in the teaching of CCSE. The responses were coded and then themed according to the three aims and learning outcomes of the framework (knowledge; attitudes, values and behaviours; and competences and capabilities) to understand preservice teachers' views on CCSE at the start of their courses. The findings suggest that preservice teachers lack key subject knowledge in CCSE to teach it effectively in schools. Hence, this paper recommends further work needs to be carried out to embed CCSE work in ITE courses across England. It is further suggested that the CCSE framework highlighted in this paper can act as a key national document to support ITE institutions to conceptualise the teaching and learning of CCSE across their ITE programmes.

Keywords: initial teacher education (ITE); sustainability; climate change; climate change education; preservice teachers; positionality; identity

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1. Introduction

Climate change is the pressing issue of our time. It intersects across all layers of society, and our future growth and development is intrinsically linked to how effectively we tackle the climate emergency. At the heart of this important work sits the next generation; the young are demanding measurable change to build a more sustainable future. This is highlighted by the work being developed by youth organisations such as 'Teach the Future', tracking the current National Curriculum to incorporate climate literacies [1]. There is an emphasis on embedding Climate Change and Sustainability Education (CCSE) across all aspects of the National Curriculum to support the knowledge; attitudes, values and behaviours; and competences and capabilities of the next generation of educators [2]. The government's strategy for sustainability and climate change [3] is encouraging and a step in the right direction. However, as [4] illustrate, the strategy does not go far enough for an educational policy shift needed to embed CCSE across the education sector. Furthermore, governments across the European Union (EU) have agreed on a GreenComp framework [5],

setting out four key sustainability competences (Embodying, Embracing, Envisioning and Acting) to support EU citizens to live sustainable lives. This ambitious framework sets out an informed and structured guidance for educators to support future generationsto live sustainable lives.

This paper provides the context for the development of a CCSE Framework [2] for preservice teachers in England. This work was conceptualised as part of a National Climate Education Action Plan [6], highlighting nine points to shape and deliver CCSE in England at scale. The action plan is included in the Department for Education's (DfE) Sustainability and Climate Change Strategy [3]. These ideas are explored and rationalised within the paper to highlight their importance in shaping climate and sustainability literacies with the next generation of teachers. The ITE curriculum is arguably crowded with the new requirement to cover the mandatory Core Content Framework (CCF) [7]. Therefore, room needs to be made in an already stretched curricula, but it is suggested that embedding CCSE across ITE courses develops and nurtures creativity and hence enables preservice teachers to critically examine delivering the curriculum in a connected and systems-thinking way [7–9].

The rationale for the aims and learning outcomes of the framework is explored to outline the thinking and subsequent sequence of activities that underpin the framework. Results of an initial survey are presented to illustrate preservice teachers' perceptions on the teaching of CCSE. These data sets aspire to argue the urgency to embed, at scale, the core skills needed by preservice teachers to progress CCSE work in a sustained, measurable, meaningful and research-informed way.

2. Literature Review

2.1. Global Context

The term 'climate change' has appeared regularly in news reports in recent years. Its significance is such that a new term, 'Anthropocene', is being used for the current geological epoch [10–13], which is being shaped by half a century of climate and environmental changes, created solely by human activity.

But what exactly do we mean by climate change and sustainability and why are they important ideas to embed across preservice teachers' curricula?

The United Nations (UN) define climate change as follows:

> Climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural, such as through variations in the solar cycle. But since the 1800s, human activities have been the main drivers of climate change, primarily due to burning fossil fuels like coal, oil and gas [14].

The definition illustrates how human actions have created the climate crisis through unsustainable consumption of natural resources. Hence, an important component of developing climate literacies with preservice teachers is developing a critical understanding of links between climate change and sustainability. How can we work with preservice teachers to enable them to develop sustainability skills and habits that intersect all aspects of human life?

A popular way of defining sustainability is using the 'three pillar model'; the pillars represent society, environment and economy. Here, it is asserted that in order to live sustainably, all three aspects must be taken into consideration [15]. However, [16] discuss sustainability as a system of connections between all aspects of life on Earth.

Education for Sustainable Development (ESD) is defined by United Nations Educational, Scientific and Cultural Organisation's (UNESCO) as follows:

> ESD aims at developing competences that empower individuals to reflect on their own actions, taking into account their current and future social, cultural, economic and environmental impacts, from a local and global perspective [17].

Hence, the work with preservice teachers is vital to support the shaping and realigning of our education system with competences to build sustainable behaviour habits with pupils.

The issues created by climate change are complex and are interconnected with environmental, social, political and economic systems. The intersectionality between these complex areas is well documented through the discourse on climate justice and how the effects of the climate crisis are being felt by the most marginalised communities not just in the Global South but across social and political divides in the Global North [18,19]. The emerging concern about the growing rate and the effects of global warming has increased since the 1980s. At a government level, an International Panel on Climate Change (IPCC) was set up in 1988 [20] to enable governments across the world to discuss ways of tackling the issue of climate change. The need to take action on climate change was reiterated in 2015 when almost every country in the world signed the Paris Agreement [21]. However, the world's climate has continued to warm. The global warming stripes, developed by Professor Ed Hawkins [22], illustrate, in colour, the warming of the planet from the 1860s to 2020s. This iconic image is a stark reminder of the work that needs to be accomplished to reverse the consequences of our carbon footprint.

At a societal level, steps must be taken to build more sustainable behaviours. At an individual level, there is an urgent need to take action to reduce individual carbon footprints with innovative programmes such as The Carbon Literacy Project [23]. This project has the power to 'boundary hop' and to support individuals to live more sustainable lives and reduce their carbon footprint [24]. Therefore, educators have an important role to play in helping young people and communities which they serve to make sense of the complexity of climate change and help communities to learn how to adapt to and mitigate the effects of climate change in their lives. A specific IPCC report (Working Group III) sets out the progress made in this area [25].

Aspirations for climate change education for preservice teachers were featured in the first conference of the United Nations (UN) with a focus on the environment, where teacher training was mentioned in recommendation 96C, [26] (p. 24). Further emphasis was placed at the Rio Earth Summit in 1992, within the Agenda 21, an action plan setting out sustainable development, with a specific emphasis on Climate Change Education Training [27]. In the Paris agreement, the significance of climate education was clearly stated in article 12, asserting 'Parties shall cooperate in taking measures, as appropriate, to enhance climate change education. . .' [21] (p. 16). However, nearly a decade on, the embedding of ESD principles remains an area of focus of all parties who signed this agreement in 2015.

UNESCO's 2030 vision for ESD with its seventeen Sustainable Development Goals (SDGs), underpinned by 169 targets, illustrates and demands each citizen of the world to play their part in achieving these goals [28]. However, the latest global monitoring report on the progress made to achieve the SDGs by 2030 indicates that the impact of the COVID-19 pandemic alongside severe climate breakdown has had a huge impact on the progress towards the SDGs [29]. Furthermore, the framework of the SDGs has been critiqued by scholars as being problematic and biased towards the most marginalised communities [15].

2.2. Climate Change and Sustainability Education in England

For climate literacies to be embedded in learning outcomes on teacher training programmes in England, the teaching of climate education needs to feature across the English National Curriculum. However, there is a lack of emphasis in the teaching and learning of climate change across the curricular provision. The Primary National Curriculum in England [30] does not explicitly mention the teaching of climate change. At Key Stage 1, in geography, pupils learn about the weather, exploring the seasons and habitats are taught in science. At Key Stage 2, emphasis is placed on climate zones in geography, and climate is explored from the perspective of learning about animals and their habitats in science [30]. At Key Stages 3 and 4 [31] (p. 77), there is explicit emphasis on the 'anthropogenic causes' on the climate. However, we suggest this does not go far enough to support the embedding of climate and sustainability education across all aspects of the curriculum. Climate education continues to be seen as subject-specific—mainly appearing in geography and science without meaningful connections made across the curriculum provision. Hence, teacher

training programmes have not yet fully embedded the teaching and learning of CCSE in their programmes. Teach the Future, a youth-led organisation highlighting the climate emergency, has recently published a report highlighting tracked changes to incorporate CCSE across the current curricular provision [32]. Finally, further information has been provided through the guidance for 'Political Impartiality in School', which suggests using scientific facts to deliver insight into climate change in schools [33].

Barwell and Hague [34] argue that to support pupils with their thinking on CCSE, authentic and meaningful opportunities should be created to support and facilitate conversations. Furthermore, visible environmental issues, such as the carbon emissions of their school, localised pollution levels or flooding, all play a part in understanding the anthropogenic impact of the climate crisis at a local level and, in turn, supports pupils to apply this understanding to a more global context. Individual agency can be developed through the acquirement of knowledge through working with frameworks such as the SDGs [28]. For this deep learning to happen, preservice teachers must be provided with opportunities to explore such ideas and create space for this level of teaching. However, individual agency can work both ways, as discussed by [35], where individuals can either build their capabilities to act upon climate change or lack those for action. Hence, preservice teachers' positionalities [36] are vital in framing discourse within the area of CCSE.

2.3. Conceptualisation of a Climate Change and Sustainability Education Initial Teacher Education Framework

Background

The recent government strategy on sustainability and climate change education [3] sets out an ambitious plan for England to embed CCSE across the National Curriculum. The National Climate Action plan's action point 2 states the following:

> "All teacher trainers and initial teacher trainees should be able to access training that empowers them to effectively incorporate climate education within their teaching across all levels and subjects" [6].

This section highlights the conceptualisation of the ITE CCSE framework, developed in response to action point 2. A survey, with a response rate of 71 participants from preservice teachers is drawn upon to highlight the case for mainstreaming CCSE. The initial development of the framework, including the aims and learning outcomes, were drawn from the Universities network paper entitled 'Mainstreaming Climate Change Education in UK Higher Education Institutions' [37]. The framework's structure facilitates flexibility in the delivery of its three learning components so that it can best suit individual institutions and courses.

2.4. Core Concepts in the ITE Framework

2.4.1. Teacher Positionality

Teacher identity is complex and evolves and develops over time. The notion of positionality is valuable to understand what knowledge, understanding and lived experiences have been faced to help shape a preservice teacher's understanding of sustainability and climate change education. This starting point can then be used to begin discussions with pupils on sustainability and climate education.

Individual positionality is vital in interpreting and critically examining situations. The notion of identity plays a fundamental part in building one's positionality. Teachers' identities develop throughout their careers, incorporating many layers [38]; hence, teacher identity is shaped through personal and professional experiences. It is argued that preservice teachers must understand their own positioning within the complex debates around CCSE before they can innovate in the classroom and feel confident to do so. Research with preservice geography teachers indicated the complexities faced in building a teacher identity in environmental and sustainability education, highlighting the value teachers place on their own and their students' lived experiences of connecting with the environment in shaping and enabling future environmental work within their communities [39].

2.4.2. Climate Justice

Climate justice is an integral component of foundational knowledge in understanding sustainability and climate change education. The intersectionality of climate justice and how our actions impact others plays a key role in building knowledge and understanding of the complex domains of sustainability and climate change education. The understanding of climate justice reinforces the notions of a systems-thinking approach to understanding the complexities of sustainability and climate change education. Preservice teachers are encouraged to look up the SDGs set out by the United Nations [28]. There are 17 goals that intersect and provide a framework to empower each citizen of the world to come together to foster a more sustainable approach to living. Preservice teachers are encouraged to study the SDGs carefully and use the goals as a framework to develop conversations about sustainability and climate change education with pupils. However, the SDGs have also been criticised, firstly for their inequity in not addressing the different starting points of nations across the world to achieve these goals that are driven in part by economic growth and, secondly, as [40] (p. 42) indicates, the SDGs represent 'a form of technocratic instrumentalization and bureaucratized rationality that can get in the way of educating for the Anthropocene'. Hence, preservice teachers need to be supported in developing an informed and balanced view of such ideas.

2.4.3. Climate Action

There is growing evidence that young people are experiencing 'eco-anxiety' [41,42], where they share a concern for the planet and yet feel quite at odds in what actions they can take to support a more sustainable future. A recent study, Ref. [43] demonstrated that pupils aged 8–9 did share anxiety around the climate breakdown but were also able to identify a range of positive actions relating to sustainable lives. Such actions included planting more trees, walking more rather than driving and having more meat-free meals. Therefore, this study underlines the importance of building concrete ways to support pupils to take action to shape more sustainable lives. These ideas reflect the notion of 'Bildung', where individuals work towards self-development to transform themselves through personal growth over time [44]. Within the context of this study, it is envisaged that preservice teachers are realigning their identities through developing a core set of knowledge; attitudes, values and behaviours; and competences and capabilities to further understand what ESD means to them and how they choose to build these skills to further the skills of their pupils, thus aligning with the principles of 'Bildung' as they build their future identities as educators. This will not only support the building of sustainable skills for themselves but also support pupils in engaging in solutions and direct actions to combat the climate emergency. One way to facilitate this is engaging pupils with nature to develop sets of skills that build resilience, nature connectedness and support pupil wellbeing. The recent work on eco-capabilities, developed by [45], supports the notion of using nature and the arts to build 'eco-capabilities' that engage pupils in becoming more resilience while taking action to build a more sustainable future.

2.5. The Aims and Learning Outcomes of the ITE CCSE Framework

The framework has three core aims and learning outcomes. Each one is discussed below to outline the development of the work.

2.5.1. Knowledge

The development of knowledge is complex and nuanced. The work in [46] argues for developing deep knowledge constructs: 'Pedagogical Content Knowledge' (PCK) must play a key role within the subject and pedagogical domains. In the case of CCSE, PCK plays a vital role in the understanding of the changes happening to our climate as a direct consequence of human impact. In addition to this, it influences the way we process and make sense of this knowledge from a geo-political and global economic context and the subsequent impact climate change has on global economics. However, as [40] argues, the

ideas of sustainability are moving more towards economic gains, as opposed to a nurturing and innate care for the planet. Hence, the knowledge driving the ideas of ESD need careful framing and critical examination to support preservice teachers and experienced teachers alike to create space for meaningful dialogue to build CCSE literacies in the classroom.

Furthermore, traditional ideas of learning and development of knowledge being confined in a formal educational setting need to be examined critically to reshape preservice teacher thinking for 'educating in the Anthropocene' [40]. Using the natural landscape and local knowledge to frame conversations, alongside using arts-based approaches [45], ideas are emerging in educational research and are worthy of note when defining the complex ideas in the teaching of CCSE. Hence, the knowledge ought not purely focus on the physical science and mitigation [25,47] of the climate emergency but focus in on broader constructs of what it means to educate individuals for the twenty-first century amidst the climate emergency.

2.5.2. Attitudes, Values and Behaviours

How can preservice teachers be supported in understanding how to teach 'affective and behavioural' change [37] (p. 3)? The commitment must be to understanding the 'what' of climate change and beginning to build concepts of 'how' to unpack this in a way that supports the building of individual agency [35] in framing such conversations. It is argued that climate literacies for preservice teachers need a deep insight into justice issues and how the global climate crisis has emerged from the legacy of colonial practices. Hence, the ideas of climate justice and the ethical dilemmas faced need contextualising in current discussion on decolonial practices to support preservice teachers in teaching in an ethical and informed way [48]. Supporting global frameworks such as the SDGs [28] in building global citizenship values and what behavioural changes look like in action at a local level to achieve SDGs are measurable approaches to support attitudes, values and behavioural skills for preservice teachers. Furthermore, recent work, such as the BERA Manifesto education for environmental sustainability, supports and highlights what a values-based and youth-informed approach for ESD might look like [49].

2.5.3. Competences and Capabilities

At the heart of aspiring to build skills in sustainability lies the notion of how our 'actions' now will affect the future. Therefore, the framework aspires to support preservice teachers in understanding a range of skills to facilitate their thinking in what competences and capabilities can be developed to sustain CCSE literacies. Adapted from the UNESCO's competencies for CCSE [17], different ways of thinking, participating and being [50] are highlighted in the framework to empower preservice teachers to analyse CCSE as a system, using critical thinking techniques to examine different aspects of life in the future, hence developing anticipatory thinking. Furthermore, building skills to support preservice teachers to actively participate in problem solving local issues linked to CCSE is also essential, e.g., preservice teachers could build skills with their pupils to look at air pollution levels within their school catchment area to create action in reducing the levels. Finally, CCSE work needs to be driven by individual values and actions, hence, how preservice teachers see themselves and the actions they take on a day-to-day level; thus, the values that drive these actions make up part of the competences and capabilities in their toolkit to teach CCSE.

3. Survey Findings with Preservice Teachers

This section draws together findings from survey 1 conducted with preservice teachers to understand their views on CCSE.

3.1. Research Design

Context

Preservice teachers from three universities across England took part in the study to evaluate the content of the ITE CCSE framework. The inclusion criteria for participation in the survey required respondents to be preservice teachers from either undergraduate or postgraduate training routes in both primary and secondary phases. Participants were not required to provide demographic information, as the intention of the study was to develop a CCSE framework through the interrogation of needs and opinions, irrespective of age and identified gender.

Table 1 provides contextual information about each institution.

Table 1. Contextual details of the Universities.

	University 1	**University 2**	**University 3**
Type and phases of ITE Programmes offered	Early Years Primary UG Primary PGCE Primary School Direct Secondary PGCE Secondary School Direct	Early Years Primary UG Primary PGCE Primary School Direct Secondary PGCE Secondary School Direct	Early Years Primary UG Primary PGCE Primary School Direct Secondary PGCE Secondary School Direct
Range of subjects offered for secondary ITE courses	Art, Design and Technology, Drama, Computer Science, Science (Physics, Physics with Mathematics, Chemistry, Biology), Modern Foreign Languages MFL (French, German, Spanish), Mathematics, English, Geography, History, Religious Education, Physical Education.	English, Geography, History, Mathematics, Modern Foreign Languages (MFL) Physical Education (PE) Religious Education (RE) Science.	Art and Design; Biology; Business Studies; Chemistry; Computer Science and Information Technology; English; Geography; History; Mathematics; Modern Foreign Languages; Music; Performing Arts (Dance) and Performing Arts (Drama); Physical Education (PE); Physics; Psychology; Religious Education; and Social Sciences.
Geographical Location	Southeast England	Southwest London	Northwest England
Type of University	Public, Research	Public, Research	Public, Research

Table 2 sets out the phases of the data collection and the tools used to collect data sets across one academic year.

Table 2. Phases of data collection.

Data Tool	**Purpose**	**Phase of Research**	**Completion of Phases**
Start point—Survey 1	Survey to understand preservice teachers' knowledge and view of CCSE	Phase 1	Completed
Reflections from teacher educators on the delivery of the sessions	To understand how preservice teachers engage with the content of the CCSE framework during taught lessons.	Phase 2 A	In Progress
Pre-service teacher Focus Groups	To gather additional data to understand preservice teachers' engagement with the CCSE framework content	Phase 2 B	In Progress
End point—Survey 2	Data	Phase 3 A	In Progress
Survey with teacher educators	Data	Phase 3 B	In Progress

This paper highlights the results in phase 1 of the data collection by sharing the analysis of data from survey 1.

4. Data Analysis

4.1. Preservice Teacher Survey 1

A total of 71 preservice teachers completed the survey; 34 primary preservice teachers and 37 secondary preservice teachers made up the sample (Table 3).

Table 3. Showing the participant details from the preservice teacher survey.

Primary Preservice Teacher Sample (n34)	Secondary Preservice Teacher Sample (n37)
Undergraduate and postgraduate preservice teachers.	All postgraduate preservice teachers were training for the following subjects:
Undergraduate and postgraduate preservice teachers.	Art and Design, Design and Technology, English, Geography, Mathematics, Modern Foreign Languages, Physical Education, Religious Education, Biology and Chemistry.

Survey 1 sought to provide an overview of how preservice teachers in England viewed the teaching of CCSE. Survey 1 had a range of questions designed to capture preservice teachers' views on the teaching and learning of CCSE. The questions ranged from multiple choice answers highlighting the confidence level of preservice teachers in a range of CCSE indicators, binary 'yes, no' answers and questions that asked preservice teachers to showcase priority areas, from their perspective, in the teaching of CCSE. Preservice teachers were also given opportunities throughout the survey to provide their thinking around their answers, hence capturing further details on their understanding of CCSE priorities. Therefore, the questions from survey 1 enabled the generation of both qualitative and quantitative data to capture preservice teachers' insight into CCSE. Key considerations such as reducing the risk of leading questions, questions that may have more than one question within them and hence cause confusion and questions that are knowledge- or recall-based were avoided [51]. Some examples of questions posed in the survey are outlined next:

> What is your current understanding about climate and sustainability?
>
> Have you developed this understanding through your formal education or through your own research?
>
> Do you feel the teaching of climate change needs to be prioritised in schools and why?
>
> Which subject(s) do you think is/are the best fit for climate and sustainability education and why?
>
> If you could design a curriculum for climate and sustainability education, what would be the areas of priority in this curriculum? List up to 5?

Content analysis of survey data enabled the researchers to include both the qualitative and quantitative elements of the questionnaire whilst maintaining an exploratory approach. Some of the questions defined a deductive parameter for coding, whilst others required thematic and inductive coding. Indeed, content analysis is viewed as a flexible methodology which permits examination of patterns in communication both inductively and deductively [52].

Analysis was undertaken by two of the researchers (NM and SM) to support independent verification of the themes emerging [53]. The responses were coded and then themed according to the three aims and learning outcomes of the framework (knowledge; attitudes, values and behaviours; and competences and capabilities) to understand preservice teachers' views on CCSE at the start of their courses. This was firstly conducted by

researcher 1 (NM) and then by researcher 2 (SM). The findings from each researcher were then discussed between them along with any coding issues in order to achieve interrater reliability (IRR) [52]. Survey 1's results help in understanding preservice teachers' views of teaching CCSE, shedding light on the gaps preservice teachers have in their knowledge and understanding in the area, hence supporting the further development of the ITE CCSE framework and adding to the knowledge in the field.

4.2. Ethical Consideration

Full ethical approval using BERA guidance [54] was gained from the university's ethics committee prior to data collection. Table 2 highlights the phases of the data collection. In addition to survey 1, further data were collected through focus group, observations, interviews and an end-point survey 2 to finish the data collection. Finally, views from academics delivering the framework were sought through an anonymised survey. All preservice teachers were fully informed of the ethical process through an information sheet and given details of the purpose of the study and their part within it. For the surveys, full information for the project was added at the start, and all participants were invited to consent via a tick box before they started answering the questions. This paper only focuses on the findings from the presurvey to understand preservice teachers' views of CCSE.

5. Results and Discussion

5.1. Preservice Teacher Knowledge

In total, 84% of the preservice teachers indicated that they had some knowledge and understanding of CCSE. They conceptualised this current understanding through surface-level indicators, such as teaching about the five R's (refuse, reduce, reuse, refill and recycle). Participants did see the teaching of CCSE as a social responsibility that needed further development though and embedding across all curriculum areas. The majority of the participants indicated that even though they had little understanding of CCSE, they would like to know more about how to teach it effectively in schools. This is a hopeful result in how preservice teachers see this area of work and hence how they see the development of knowledge and understand of CCSE, supporting preservice teachers to build their agency in teaching CCSE effectively. The data showed how preservice teachers see the need to develop CCSE as part of their training and for this aspect of learning to be embedded within the school curricula, as well as how they could shape these changes as beginner teachers. The responses from the participants suggested that they felt teachers had a responsibility to implement climate education and that they see it as a social responsibility for everybody. The preservice teachers cited that they had gained their prior knowledge from six key areas: newspapers, social media, YouTube, their university studies, school and from personal research. Some examples of responses were the following:

> 'Managing waste within their school according to the 5 Rs hierarchy- refuse, reduce, reuse, refill, recycle'.

> 'Basic- understanding that we should try and be as sustainable as possible- but unsure how to put into practice'.

> 'I have little understanding but would most definitely like to incorporate it into my own teaching and help increase awareness'.

Further nuanced details were noted where preservice teachers discussed the need to develop understanding of sustainable living with pupils to support CCSE. This ranged from a clear insight into the reasons for the loss of biodiversity to understanding the impact of carbon emissions on global temperatures.

> 'Global average temperatures are rising, as evidenced with the increase in the number of heatwaves. . .'

> Teaching of the risks posed by climate change and its causes. As well as how sustainability can decrease the effect of climate change, and what we can do to support and encourage this'.

Preservice teachers appeared to lack knowledge of government policy in this area—only one respondent indicated an awareness of the DfE strategy [3].

When asked how they developed their knowledge of CCSE, the majority, just over half (57%), indicated that this was achieved through their own research. The data also indicated that 43% indicated learning about CCSE through their formal education. Linked with this point, when asked which subject CCSE fits in, most responses indicated geography, closely followed by the sciences, indicating the subjects where CCSE is mentioned in the National Curriculum. Figure 1 illustrates the range of subjects indicated by preservice teachers. However, it is positive to note that a healthy proportion stated that CCSE should be taught across all subjects.

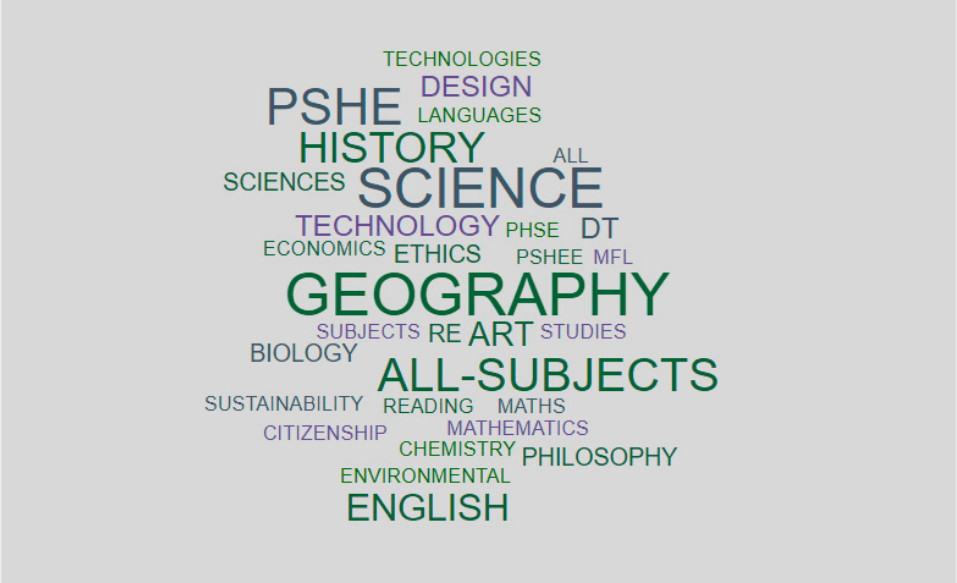

Figure 1. Word cloud sharing preservice teachers' stated subjects that are the best fit for the teaching of CCSE. (PHSEE, PHSE and PHSE—personal, social, health and economic education; MFL—modern foreign languages; DT—design and technology).

5.2. Preservice Teacher Attitudes, Values and Behaviours

Preservice teachers' attitudes, values and behaviours drawn out from the data suggest their shared consensus in prioritising CCSE, and 95% of the participants agreed with the statement that 'teaching of climate change needs to be prioritised in schools'. They shared statements illustrating their attitudes, values and behaviours towards the teaching of CCSE, such as the following:

> 'Most pressing issue of our time'.
>
> 'It affects future generations'.
>
> 'Climate change is an important issue and can be very daunting and cause anxiety. Therefore, it is important to have children become knowledgeable about how they can help'.
>
> 'Watching frozen planet, reading news, knowing the seriousness of this for our younger generations'.
>
> 'To inform the next generation of adults what they can do now to create a better future'.
>
> 'It is for our student's future wellbeing'.

Participants shared a sense of urgency through their responses to this question. As future educators, they felt a real sense of responsibility to be part of the change and to support future generations to live more sustainable lives.

The participants emphasised the pressing need to develop CCSE because of the climate emergency being one of, if not the most, predominant issues of our time. Furthermore, the preservice teachers who took part in survey 1 shared the fact that the pupils they are teaching will bear the burden of the crisis; therefore, equipping them with the skills needed to tackle the crisis was a priority for them as future educators:

> 'It affects children at all stages in their future, and the climate crisis needs to be acted on'.

> 'They are the generation that will grow up to be impacted by climate change. It is going to be an extremely prominent issue in their adult lives'.

> 'Climate change will rely on the young generation as these are the adults of the future. They can help tackle climate change'.

Preservice teachers also shared insight into 'eco-anxiety' and emphasised that the teaching and development of CCSE was a wellbeing issue. Some direct quotes are shared below:

> 'We need to raise awareness and start informing children from a young age so not to scare them but allow them to feel confident to make the changes needed'

> 'It's for our student's future wellbeing'.

> 'Climate change is an important issue and can be very very daunting and cause anxiety. Therefore, it is important to have children become knowledgeable about how they can help'.

However, a minority (3%) indicated that CCSE should not be prioritised over other perceived 'significant' subjects, such as English and mathematics. This statement brings the notion of formal education to the forefront and how CCSE is still potentially viewed as a separate subject, suggesting a lack of knowledge on how to embed CCSE into everyday teaching. For instance, one participant cited that teachers are focused on exam outcomes, so therefore are unable to prioritise CCSE over this. A further comment on their own lack of knowledge and not being able to 'empower' pupils with ways of tackling climate change were reasons given to not prioritise teaching it. Hence, the data also illustrate how the participants do not seem to yet visualise how to incorporate CCSE into their teaching and are seeing it as something 'standalone' and to be taught explicitly. There seems to be a strong desire for knowledge on this though, and the value placed on it is high. The attitude towards the teaching of it is also positive because of a range of reasons, and the variety of lessons suggested to be used is wide, pointing towards the notion that preservice teachers see a place for CCSE across the curriculum, including personal, social, and health education (PSHE) and citizenship.

Finally, preservice teachers valued the need to incorporate CCSE as part of their training programme. They felt it was of vital importance for them to develop their knowledge and understanding in the area to teach CCSE in the most effective way. Yet, it was also cited by the participants that the placing of this teaching is important and that for it to have maximum impact, coverage in the latter part of an ITE course or as an Early Career Teacher would be most effective, so that the individual is aware of what is already being done in school settings.

5.3. Preservice Teachers' Competencies and Capabilities

Preservice teachers were asked about their confidence levels in teaching CCSE. Over half (58.2%) indicated that they were either not confident or only slightly confident in teaching the subject. The qualitative comments also highlighted a mixed response, and participants cited the following:

'I have some understanding about climate changes. But need to prepare thoroughly before teaching pupils'.

'I do good reading about climatic change and learning myself to project it in the classroom, but still need very good knowledge to be very confident to teach'.

Those who felt they were less confident explained the following:

'My current subject knowledge of this topic is limited'.

'I feel that I need to develop my knowledge and think of lessons that would enhance the children's learning and understanding'.

'I don't think I have enough knowledge and because it is such a heavy topic, I think we need training as trainee teachers rather than going into school and not giving as much importance as we should'.

There appeared to be a clear theme of acknowledging a lack of subject knowledge in the area to teach it effectively. Further responses indicated that although preservice teachers felt that they knew quite a lot about environmental and sustainability issues through their own research, they would not be able to turn that knowledge into structured lessons for their pupils, hence indicating the need for training to support the development of this Pedagogical Content Knowledge (PCK).

The participants also described which areas they would like covered within the curriculum to increase their competency. The topics named can be grouped into five key themes of climate change, sustainability, energy, education and responsibilities (Table 4):

Table 4. Highlighted themes generated from data collected from question 9 asking preservice teachers about CCSE curriculum design.

Themes	Codes
Climate change	Causes/effects/action/impact on humans and animals/clothes/examples of/global warming/pollution/carbon footprint/climate future/greenhouse gas/human behaviours
Sustainability	Conservation/technology/charity/development/recycling/cities/eco-friendly/composting/food/coastal erosion/protection
Energy	Consumption/renewables/cleaner energy/emissions/fossil fuels/transport
Education	Research/policies/evidence/individual and collective action/history/geography/science/the role of teachers/networking/equity/global outlook
Responsibilities	Government/individual/collective/green investment/social/decision makers/influencers

Preservice teachers highlighted a range of contributions from their thinking on future curriculum design to support pupil teaching and learning in CCSE. The themes emerging illustrate the broad range of areas preservice teachers showcased, including the cause and effect of the climate crisis, looking at the notion of renewable sources of energy and supporting knowledge and understanding of what actioning sustainability means and what these actions look like in schools.

5.4. What Has Survey 1 Highlighted about Preservice Teachers' Views of CCSE?

The key findings from survey 1 highlight the need for a coordinated and structured approach to developing CCSE within teacher training institutions in England. The results underline preservice teachers' views on the teaching of CCSE and the importance they place on developing their own knowledge and understanding in the area. However, the survey also highlights preservice teachers' reticence to develop CCSE in their practice. One possible reason for this could be the overcrowded curriculum and the overwhelming nature of training to be a teacher being compressed into one academic year for most preservice teachers. Therefore, it is suggested that government policy ought to go further to enable the embedding of the core competences of CCSE across all teacher training courses in order to create space in the curriculum. Furthermore, if such a policy is to be developed

and implemented, it will further highlight and illustrate the urgency of CCSE being an integral part of all preservice teacher training courses in England. The current government strategy [3] does not go far enough to engage with the development of CCSE for preservice teachers, hence leaving a gap at a statutory level in the implementation of this vital area of training. Ref. [4] suggests educators do not merely want more knowledge to teach aspects of CCSE but need strategic changes in government education policies to give space in the curriculum to teach CCSE in a meaningful and connected way.

The implementation of the CCSE ITE framework, at scale, across England and beyond does poses many challenges. These stem from a crowded curriculum for ITE [7], coupled with constraints on timing preservice teachers' experience in the development of their content knowledge. Therefore, it is argued that to support the successful implementation of the principles of CCSE, government policy needs to reflect these changes at scale. This would include a reconceptualisation of what the curricula looks like through all stages of education, including Teachers' Standards. Indeed, a lesson can also be learnt from Scotland's implementation of 'Learning for Sustainability' (LfS), where sustainability is embedded in all aspects of the education curricular, including the Teachers' Standards [55,56]. However, there still remain challenges to implementation in a measured and authentic way to support LfS. Hence, the authors argue that a balanced, authentic and localised view must be taken to inform practices of CCSE.

5.5. Implications, Limitations and Next Steps

From the findings of this research, it is suggested that preservice teachers are in favour of learning about CCSE in their teacher training courses. Knowledge in CCSE appears to come primarily from their own research or from previous study. Generally, knowledge of CCSE seemed to connect to climate change and sustainability rather than the ability to incorporate climate justice into their teaching. The link between CCSE and climate justice and, in turn, how to teach this in their subject, was less strong. Attitudes, values and behaviours are positive towards its teaching, although the participants in this study did not seem to yet know how to embed this within their subject, and some still saw CCSE as a standalone topic to be taught explicitly. Yet, these preservice teachers were positive regarding it being taught across the curriculum. It appeared that the preservice teachers needed more visible examples of what CCSE might look like within their own subject/phase, although there were creative examples in the data of how this might work in schools. Hence, programmes such as subject-specific teacher professional development for CCSE are vital in supporting this change. The programme 'Teaching for Sustainable Futures' [57] is a good example of how carefully considered teacher professional learning can support the development of subject-specific climate literacies to enable change.

The other implication seemed to be the timing of the teaching and where it fits in the ITE framework. There were suggestions that it should not come too soon and that it is better placed later in a trainee curriculum. Plus, it would seem that there needs to be more opportunity to discuss CCSE in school placements, and it is advised that settings-based tasks which can be part of the ITE framework are given more prominence and connected to the curriculum. It is also recommended that more preservice teacher discussion and sharing of best practice is facilitated, and subsequent research stemming from the phased evaluation seeks to further uncover the impact of the implementation.

Although this research has shed light on the teaching of CCSE to preservice teachers from three universities in England, it has several limitations. Firstly, the sample size of the data could benefit from being larger to capture data from more institutions across England and by having a larger number of participants taking part in the survey to gather further in-depth insight. The research could develop further through a longitudinal, in-depth study of mapping out the journey of a group of preservice teachers who are taught CCSE using the ITE framework [2] into their Early Careers to further understand how they align their identities and build their positionaliteis as educators in the field of CCSE.

6. Conclusions

The data sets shared show that preservice teachers have a clear insight into the climate emergency and the role education needs to play in building agency. However, the participants who took part in the survey 1 suggested that they lack the subject and pedagogical knowledge to teach this topic effectively. Survey 1 has shed light on the gaps in knowledge, and further insight will be gained through comparing these data sets with a postsurvey and the results of the remaining data collected as part of this ambitious piece of work. Therefore, it is concluded that the framework for CCSE for preservice teachers is a step in the right direction to implement a comprehensive programme of training for teachers in developing climate literacies. Through teaching of the ITE CCSE framework across the different phases of education, it is suggested that preservice teachers will develop a clearer understanding of their own positionality with CCSE, consider how to incorporate teaching of CCSE in their subject/phase and discuss and collaborate on what actions they can take as individuals, as teachers and as future leaders of education.

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