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Knowledge and (un)certainty in climate change education in India

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Abstract

This paper explores teachers' conceptions of climate change knowledge, contributing to the growing body of work on the geographies of climate change. The paper focuses on the data generated through in-depth semi-structured interviews with a sample of 48 teachers in India to address the research question: What discourses about climate change knowledge are being constructed by teachers in India? We argue that teachers' lesson planning and searches for information are at the forefront of the changing ways in which individuals engage with, find out and construct meaning about climate change. These teachers' beliefs about climate change are very strongly held, even in the face of a perceived lack of expertise or understanding: climate change is described as the 'need of the hour', which this work understands as not only involving material impacts and processes but also important epistemological, collaborative needs through which education might contribute to public reasoning about climate change. Through this analysis we present a 'certainty problematic' as a heuristic device that foregrounds tensions between the inherent uncertainty of knowledge and (against climate denialism) certainty about anthropogenic climate change.

KEYWORDS

certainty, climate change education, crisis, knowledge, public reasoning

Key insights

What is the main issue that the paper addresses?

This paper addresses the limited research attention that has been given to global majority teachers' perspectives on climate change education. It develops our understandings of the discourses about climate change knowledge that are being constructed by teachers in India.

What are the main insights that the paper provides?

Teachers in India in our diverse sample across geographic regions of India, subjects and phases of education agree on the importance and urgency of climate change education. Teachers navigate complex knowledges around climate change, including a 'certainty problematic', and are calling for more locally specific climate change teaching resources.

INTRODUCTION

Geographies of climate change are attracting significant and increasing attention across geoscientific, discursive, existential, institutional and other dimensions. The complexity and immensity of climate change raise important questions about the ways in which education could and should contribute to 'public reasoning' around this issue and beyond (Castree et al., 2021). Education offers significant opportunities to effect change in epistemic cultures and increase the quality of public reasoning. The scale of this potential impact is pronounced in the example of climate change education in India, where over 250 million children are in primary or secondary education (World Bank, 2022), over 40 million are in higher education (HE) (Ravi et al., 2019), and whose future emissions will have globally significant consequences (Dubash et al., 2018; ITF, 2021; Saryal, 2018). The focus of this study—teachers in India—also makes an important contribution because of the Anglo-American dominance of previous attention to information and climate change education (Puttick & Talks, 2021). Switching scales between the global and the local, and the geopolitical demands on that region from a climate lens, raises questions around teachers and their relationship to the construction of ideas about climate change, and in particular how global, national and local concerns are distilled into—and produced through—these discourses.

Our use of the term 'public reason' draws on recent calls for a *politics turn* in global environmental assessments (Castree et al., 2021), to centre vibrant democratic society. In these calls, the idea of public reason centres the importance and expectation of reasonable disagreement about contestable concepts. We define public reason as open communication and dialogue about claims, values and their justifications. In order to be 'public', the explanation of these claims and values should happen in ways that are, as far as possible, open and accessible (i.e., understandable) to all. There are deep relations between public reason and the idea of democracy itself (Rawls, 1997), and also between public reason and Stenhouse's conception of research as systematic enquiry that is made public and exposed to collective criticism (Stenhouse, in Rudduck & Hopkins, 1985, p. 120). For Stenhouse, there is also an important sense of reasoning (or the 'utilization of knowledge') best happening through relationships: 'communication is less effective than community in the utilization of knowledge' (Stenhouse, 1975, p. 223). Formal, publicly funded education bears

considerable responsibilities for such communities contributing to public reasoning, and this importance adds to the contested, politicised debate around what is (and is not) taught. The current paper recognises the importance of education—and more specifically, teachers—for public reasoning. This is not primarily about identifying and correcting 'misconceptions' or errors in teachers' knowledge about climate change, but carefully seeking to understand and then productively engage with climate change education: it is about developing 'new stories about the nature and merits of "intra-disciplinarity", ones better attuned to the role of research in fostering democracy in our "post-normal" times' (Castree, 2016, p. 328).

Climate change is receiving increasing attention in education in India, including some investment in teaching resources and teacher professional development, particularly through online spaces (Chopra et al., 2019). However, there are currently few dedicated courses at either school or HE level. At HE, the University Grants Commission (UGC) provides a model curriculum for different subjects which most colleges tend to follow. The last update to the model curriculum was in 2001 and gives little mention of climate change, for example, featuring it as a small part of a second-year undergraduate geography paper titled 'Physical Geography II: Climatology and Oceanography'. Additionally, while the Supreme Court of India has made it mandatory for all colleges/universities to offer a 6-month course on environmental studies (Dilay et al., 2018), climate change is only a single topic in one of the eight units, titled 'Social Issues and the Environment'. Therefore, the amount of mandatory attention to climate change in HE curricula is negligible. Climate change is not part of the earth sciences model curriculum, or of any other subject. At the school level, different boards of education introduce some climate change information in their environmental sciences modules (Chopra et al., 2019).

India is a significant player in climate politics, with a duality with regard to emissions: it is a minor contributor to past emissions, but a major projected contributor to future emissions, albeit not on a per capita basis. More recently, India has increasingly become a testing ground for policies that internalise climate considerations into development (Dubash et al., 2018). This educational and larger climate policy context all informed our study design to explore climate change education across multiple disciplines, phases of education and states. Teachers' practices, including preparing for a lesson and searching for sources of information, are at the forefront of the changing ways in which individuals engage with, find out about and construct discourses about climate change, and these changes have far-reaching consequences for public reason and the ways in which responses to climate change are conceptualised and undertaken. This paper contributes to analyses of climate change education by focusing on the discursive construction of climate change by teachers in India, understanding 'climate change' as—in part—an abstraction: 'climate change' is as epistemological as it is material and real. The production of meaning through teachers' discourse focuses attention on temporal, conceptual and political dimensions of climate change, speaking to debates about knowledge politics and expertise in climate change (Mathur, 2015, 2017) and to questions around what these narratives say about hegemonic Anglo-American conceptions of climate change (Manzo & Padfield, 2016) which dominate—as in other areas—concept metaphors and theoretical resources (Jazeel, 2021). Our focus is on formal education across a wide range of phases, from primary to HE. As a (generally) state-funded public service, formal education is an important part of broader infrastructures supporting public reason, which also place certain demands on teachers and play an important role in curricular decisions.

We now critically examine the key themes developed in the paper: space and time, contestation, (un)certainty and, following this, present the study design of in-depth semi-structured interviews with a purposive sample ($n = 48$) of teachers widely spread across India, including multiple subjects and phases of education in India. The analysis focuses on the discourses teachers construct about climate change knowledge, in which we use

'discourses' to describe the meaning-making that teachers engage with—an approach that sees climate change as (at least in part) an epistemological object that teachers construct. The findings are presented through the themes of climate change knowledge boundaries, climate change knowledge factors, space and climate change knowledge, time and climate change. Drawing together insights across these areas, the discussion on certainty and climate change knowledge presents the 'certainty problematic' as central to the challenge facing teachers attempting to navigate the complexity of climate change education. The very high degree of certainty with which teachers' beliefs about climate change are shown to be held in our accounts highlights the need for reflecting on the certainty problematic in ways that support positive contributions to public reasoning about climate change.

SPACE AND TIME

Teachers' practices are situated within complex spaces that cross spatial, temporal and epistemological constructs and involve individuals navigating a range of social, political and economic agendas embedded in digital spaces, modes of knowledge dissemination and colonised modes of knowledge production. Climate change is problematic because it is complex, global, *wicked* and inherently hybrid (Popke, 2016), as illustrated by: the breadth of fields shaping our understandings of global climate systems (e.g., through the IPCC—the Intergovernmental Panel on Climate Change); the distinctive geographies of knowledge production about climate change (Castree et al., 2021; Hulme, 2021; Mahony, 2015; Mahony & Hulme, 2012, 2018)—particularly in terms of regional imbalances in the IPCC (Ford et al., 2016) and growing polarisation around climate change knowledge on social media (Falkenberg et al., 2022); the emotional and affective dimensions of climate anxiety (Clayton, 2020); the inherent intersectionality through which impacts are experienced and the deep entanglements between climate change, colonialism and race (Sultana, 2021a); tensions in how we conceptualise and ascribe responsibility for climate change (Gahman & Thongs, 2020; Yusoff, 2018b) and in policy responses (Greer et al., 2021). Recent examples of weather outliers, and popular media narrations of these events, illustrate the complex knowledge politics around climate. The temporal differences between weather and climate are significant, and the modelling of extreme weather events establishing causality from anthropogenic climate change foregrounds epistemological, pedagogical and political questions (Ettinger et al., 2021; Osaka & Bellamy, 2020; World Weather Attribution, 2021). There is an important sense in which we come to know 'the climate' through algorithmically mediated representations, and it is this computer modelling that brings the climate 'into being as an object for governance' (Machen & Nost, 2021, p. 4). It is in many senses the archetypal global issue, but it is also effected from and experienced in and through specific localities; temporally, it is emergent through and understood along geologic timescales, but also in the immediate, urgent discourse of crisis and emergency. Understanding and responding to climate change necessarily requires multi- and interdisciplinary work, highlighted in analyses of climate modelling arguing for an expansive consideration of ethical and political dimensions in ways that resist collapses into scientistic apolitical decision-making (Castree et al., 2021; Osaka & Bellamy, 2020). These political, disciplinary, spatial and temporal complexities combine to present challenges for teaching about climate change.

Contestation

How we speak about the climate is highly contested and characterised by normative uncertainties (Billi et al., 2019). Describing climate change through the prism of *crisis* and

emergency has grown rapidly. 'Climate emergency' was the *Oxford Dictionary*'s word of the year in 2019 (OUP, 2019), becoming more than 100 times as common in 2019 than 2018. Indian media's increasing use of climate crisis—such as referring to the IPCC's sixth assessment report as the 'IPCC climate crisis report' and Indian government ministers' descriptions of the 'current climate crisis' (Sirur, 2021)—is one example of the shift to replace climate change with climate crisis. However, Castree (2020b, p. 31) cautions against a 'too-hasty acceptance of the notion of a "global environmental crisis"' as part of a broader project critically examining the metaphors used to imagine, explain and discuss net-zero targets, carbon dioxide removal and global environmental assessments (Castree, 2020a; Castree et al., 2021). *Crisis* foregrounds the importance of temporal dimensions: crises are urgent and demand immediate responses. Yet the 'slow violence' of climate change (Nelson, 2016), and the differential—racialised, classed, gendered—experience of this slow violence, is not (only) something future, but past, present and future (Sultana, 2021a). The dimensions of space, time and contestation combine to create challenges for teachers, each framed within cross-cutting notions of (un)certainty that powerfully shape educational discourse around climate change.

(Un)certainty

(Un)certainty underpins, disrupts and challenges multiple aspects of climate change as public discourse and as a focus of education (Mackie & Murray, 2020; Mahony & Hulme, 2012). Formal, publicly funded education bears considerable responsibilities for contributing to public reasoning, and this importance adds to the contested, politicised debate around what is (and is not) taught. Examinations drive many curricular decisions, and awarding bodies are bound up with the ways in which content is presented, for example, through authorising textbooks. It has been common to emphasise the uncertainty amongst scientists in school textbooks, many of which are authored in UK and US contexts (Busch, 2021; Deignan et al., 2019), misleadingly framing this uncertainty in terms of scientific consensus about 'whether it is occurring as well as about its human-causation' (Román & Busch, 2016, p. 1158). This uncertainty is expressed through simplistic ideas about *doubt* of the kind that have been financed by the petroleum industry (Radin, 2019), while the presentation is, paradoxically, made in certain and highly authoritative terms. We describe one aspect of these issues below through a heuristic: *the certainty problematic*. There are multiple dimensions of uncertainty associated with climate change and, in Mehta et al.'s (2022) terms, we focus specifically on epistemological aspects. The problematic revolves around two aims that climate change education must navigate and which appear to be in tension: firstly, that against popular ideas about sceptical climate denialism based on beliefs about scientific uncertainty (Boykoff, 2007), we can confidently (certainly) hold the position that anthropogenic climate change is real (Rousell & Cutter-Mackenzie-Knowles, 2019); secondly, that epistemological commitments about epistemic quality and public reason include general principles about the inherent tentativeness (uncertainty) of knowledge about climate change (Yeh, 2015). In one sense this problematic is common across all knowledges: 'uncertainty is an unavoidable aspect of any scientific endeavour, and climate change is no exception' (Lewandowsky et al., 2015, p. 1). The *certainty problematic* is proposed here in the specific context of climate change education, although it applies elsewhere in geography, particularly where there is an intention to stimulate action and take normative positions about what people ought to do, with the extent of the problematic varying in relation to the urgency with which the issue is framed. A similar tension is echoed in Ettinger et al.'s (2021) discussion of how extreme event attribution might be used in public climate change communication, 'expressing scientific uncertainty without undermining accessibility of key findings' (p. 341). The most

recent IPCC report (IPCC, 2021, ARP 6) uses 'uncertainty' 1678 times and 'confidence' 6980 times, mostly preceded by a qualifier of low, medium, high or very high. Navigating ideas around certainty is a fundamental part of the challenge in teaching about climate change. The dominant position in the most recent climate change education research and discourse is to prioritise the first aspect of the problematic. That is, arguing that we can be certain about anthropogenic climate change, often expressed in terms of basic facts around which it is assumed there is indisputable consensus (Acton & Saxe, 2020, p. 809).

Our main aim in the current study is to listen carefully to the ways in which teachers in India navigate these complex challenges. The main research question is: *What discourses about climate change knowledge are being constructed by teachers in India?* We use the term 'discourses' to highlight our interest in the detail of the particular words and phrases teachers use to discuss the idea of climate change.

METHODOLOGY

The current paper draws on a larger study of teachers (from primary to HE) in India, primarily based around a survey that we conducted exploring climate change education futures in India with teachers who had registered to attend a professional development course for teaching about climate change. We sent invitations to participate in the survey via email, and received over 500 completed survey responses. Following analysis of this survey, we invited a purposive sample of teachers to participate in individual semi-structured interviews which were designed to explore the ways in which they described how they conceptualised and came to know and teach about climate change. For this purposive sample we prioritised the locations of teachers (with the aim of maximising the distribution of participants) and their gender (aiming for approximately equal representation). Secondary to these factors, we considered the teacher's main subject and phase of education (ensuring there was some representation across subjects and phases of education). We conducted 48 interviews with a range of teachers, and this number allowed us to sample widely across different states (Maharashtra, Tamil Nadu, Andhra Pradesh, Jammu and Kashmir, West Bengal, Punjab, Bihar, Jharkhand, Chattisgarh, Sikkim, Delhi, Madhya Pradesh, Uttar Pradesh) and genders (25 female, 23 male). In the secondary factors of phases of education, the sample included primary (3), high school (8), undergraduate (19) and postgraduate (18), across the subjects of social sciences, law, chemistry, earth and environmental sciences, mathematics, biochemistry, physics, biology, humanities, forestry, economics and literature. We achieved the geographical spread of participants but there is an over-representation of undergraduate and postgraduate teachers and earth and environmental science teachers (the largest individual subject, at 14). Our use of *teachers* (rather than differentiating, say, between school teachers and college professors) follows the focus of this paper; we are mainly exploring the discourses they construct in the specific context of teaching about climate change.

We designed the interview schedule (Appendix S1) after initial analysis of the larger survey to follow up on issues raised in the survey, for example, about their reasons for choosing to use particular sources of information in their teaching about climate change. The semi-structured interviews all took place online between February 2020 and June 2021. They were audio recorded and we gave the option of speaking in English or Hindi; a combination that was expected to ensure that all teachers were able to communicate in a language they were comfortable speaking. Most chose to speak in English, and all interviews were transcribed verbatim. Those that were conducted in Hindi were then translated by the researchers (anonymised for review) into English. The data was analysed using an iterative, thematic approach that was conducted collaboratively across researchers on the team. Our focus on 'discourse' (Gee & Handford, 2023) involved us returning to the data to ask: How

do the teachers understand climate change knowledge? What words and phrases do they use to describe climate change knowledge? The collaborative iterative approach towards the analysis involved us separately reading transcripts to ask these guiding questions, and then coming together to critically reflect on and discuss the different analyses. Following this discussion, we returned to further rounds of analysis through which we sought to gain deeper understanding of the texts and discourses through which the teachers described climate change knowledge.

The main ethical consideration was related to the COVID-19 pandemic, which affected India particularly badly during this period. We wanted to ensure that colleagues and teachers were not further burdened by this research, and so we went to additional lengths to ensure there was no obligation to participate, including extending the period over which interviews were conducted. All teachers are referred to using pseudonyms, and transcripts were scrutinised to ensure that no individually identifying detail was included, to help preserve confidentiality and anonymity (BERA, 2018). For all direct quotations cited below, the participant's pseudonym is followed by their gender, state of residence and the main phase and subject they teach.

CLIMATE CHANGE KNOWLEDGE BOUNDARIES

The interconnected nature of climate change was a strong and common theme in the way that teachers described how climate change should be positioned in the curriculum. It was not seen as an issue that any believed their subject had special ownership over, but instead needed to be considered across all subjects. There was agreement across this highly diverse range of teachers about the partial, incomplete insights their own subject offered:

> *So in every field of study whatever you're doing, be it you as an architect or you as a policy expert who's taking policy decisions or you as a legal background or social or just anything, so irrespective of the field of study that you indulge in, it is going to have some or the other impact on climate change and it's the other way round also*.
> (Neysa, female, Maharashtra, postgraduate, earth and environmental sciences)

Across different subjects, and more widely across societies, there was an expectation of '*widespread cooperation*' (Bhuv, male, Delhi, undergraduate, biochemistry) around shared aims:

> *Climate change education is most important, and should have been started 10 years back. Anyway, better late than never. It should be integrated with all sorts of curriculum—physical sciences, chemical sciences, or social sciences*.
> (Umaid, male, Bihar, postgraduate, electrical engineering)

Many described the tensions between policy and institutional practices that are organised around discrete disciplinary structures, and the complexity of climate change that freely and simultaneously moves across multiple disciplinary frames:

> *It is really interdisciplinary, involving social sciences, humanities, physical sciences, atmospheric sciences, geography and geophysical sciences. These are all done in a very fractionated way. There is no nationally directed educational policy towards this kind of thing. There are a number of ministries of the central and state governments who are involved in these areas, but there is little coordination between, say, the Ministry of Earth Sciences or other branches, the*

> *Department of Science and Technology. There are a number of government departments which are involved, including the Department of Atomic Energy. There is little coordination, and we need overarching and concerted action on behalf of people as well as the government*.
>
> (Naksh, male, Maharashtra, postgraduate, chemistry)

The purpose of doing the hard work of trying to teach about this highly complex issue was framed in ambitious terms around protecting and sustaining the world, driven by duty, beauty, respect and, most fundamentally, '*survival*' (Malika, female, West Bengal, undergraduate, earth and environmental sciences). How we might come to know about climate change in order to protect the planet and survive was described through a series of hierarchically related knowledges.

CLIMATE CHANGE KNOWLEDGE FACTORS

Many teachers described a conception of knowledge in which 'basic facts' or 'basic science' provides a necessary first step: necessary in terms of the teachers' starting point for their planning and teaching about the topic, needed for providing students with knowledge without which they would be unable to progress to more complex understandings; and necessary in terms of the minimum level of shared understanding that all citizens ought to have. There is a need for the '*basic understanding of the children*' and the '*basic information*' (Sayra, female, Maharashtra, high school, physics). Many teachers freely used 'we', often positioning students and teachers in the same collective: '*if we don't know the basic science of climate change, then also it is the same thing, we won't realize the importance*' (Zala, female, Uttar Pradesh, undergraduate, earth and environmental sciences). The aim of understanding the basic knowledge or the 'simple information' is to move beyond: '*climate change is much more, you know, deeper in understanding that you need to understand the consequences more than you know, the causes here…*' (Zara, female, Delhi, undergraduate, biochemistry), and this moving beyond is applied inclusively across humanity. The collective *we* was applied across phases of education, for example, in Vamil's (female, Kerala, high school, biology) account there is a call for youngsters and university faculty to both be aware: '*I think it is very important and is a critical matter of which the youngsters as well as the faculty members should be aware of*'. Asmee (male, Andhra Pradesh, postgraduate, humanities) used the terms '*everyday science*' alongside '*basic science*' to communicate the essential and universal nature of this knowledge: '*you need to know this is, this is part of basic science, part of everyday science where you need everyone should be knowing*'. Many teachers described their own understandings in fairly hedged terms, and so there was a distinction between the nature of knowledge about climate change and teachers' grasp of that knowledge. For example, Naksh (male, Maharashtra, postgraduate, chemistry) described:

> *I would say it's a lack of overall understanding. Things are changing fairly rapidly … Our education system has a lot of inertia built into it for good reasons, both economic and political. We have not been able to change these things, but it is time we did change—because things are developing very rapidly. So it's a lack of knowledge and the wherewithal to come to grips with the situation quickly, both on the part of the people, our government, and even our faculty*.

One of the challenges of teaching these *basics* was explained in relation to the information about climate change that students access online. The availability of information about climate change online is sharply contrasted with the absence of any relevant textbook, offering a striking example of the speed with which different sources of knowledge have moved, and of

the different expectations that teachers place on them. The role and purpose of the textbook (across all phases of education) was described as conveying the basic concept—in this example, the global circulation model (GCM)—which even the abundance of information through online social media has failed to inform students about:

> *Suppose I am discussing climate change in the classroom, so they first must have basic knowledge. So, what is climate change, how is it going to impact. So, from Facebook or some other form, they are getting climate change news. So, in news only they are listening* [to] *this climate change. But in study, there is no textbook available. So, in our library also there is no textbook. So, we have all old textbooks here. So, there is no textbook related to climate change. So*, [the] *basic concept also they don't know, even though they know what* [the] *GCM model* [is].
>
> (Laksh, male, Haryana, undergraduate, earth and environmental sciences)

Alongside absent knowledges were descriptions of fake news, with teachers describing sources of information they choose to use according to notions of trustworthiness and credibility. Amid the complex ethics surrounding access to and mediation of information in online environments (Amoore, 2020), the teacher needs to enact moral clarity, weighing what is true, authentic, trustworthy and credible, issues that were often described with reference to COVID-19. Ideas about science underpinned notions of authenticity and truth. For example, teachers often described a single underlying truth, and '*studying what is the real cause and then what is happening because of it*' (Viti, female, Telangana, high school, biology). Government sources carried a high degree of credibility, for example, describing SWAYAM (a government-funded repository of teaching materials: https://swayam.gov.in/) resources; '*trust is there because it is a government facility, because* [a] *government platform is providing you a course*' (Zala, female, Uttar Pradesh, undergraduate, earth and environmental sciences).

Across all interviews there was a shared belief in the certainty of climate change knowledge. Basic facts and science that are beyond dispute. So there is a moral imperative to know how to teach others about them. In Anil's (male, Andhra Pradesh, postgraduate, earth and environmental science) words: '*Of course they may not be able to prove scientifically but everybody is experiencing it*'. The embodied, experiential knowledge that *everybody* has means that even if '*they*' cannot '*prove scientifically*', this does nothing to the certainty with which beliefs about climate change may be held. The use of '*belief*' to describe this knowledge seems to function in ways that move the knowledge to increasingly certain levels, and this movement was also seen as an aim of climate change education, so that:

> *More of the belief they have should become stronger. When you start believing and you say and confirm to yourself that the thing is happening like you are sure something is happening. I am sure something is happening and that's the reason why we are having this conversation …*
>
> (Nadee, female, Kamataka, undergraduate, social sciences)

Beliefs about climate change are also strengthened through observing natural hazards, listening to the ways in which the world itself speaks of climate change and '*is a witness*':

> *… they have watched several videos about* [the] *Artic and Antarctica and all those things and they know the crisis of wildlife of* [the] *Arctic and Antarctica. Okay. And forest fires. That is one of the other major catastrophes. These are*

> *the examples of climate change. Why are natural calamities increasing? The frequency has increased. So it is a witness*.
> (Anil, male, Andhra Pradesh, postgraduate, earth and environmental sciences)

The certainty with which these teachers describe climate change knowledge contrasts strongly with the findings of other studies exploring teachers' opinions on, and feelings about, climate change, particularly in a US context (Lombardi & Sinatra, 2013; Sezen-Barrie et al., 2019). These US-based studies continue to show some teachers holding climate denialist positions. The contrasts may be related to the different discourses around climate change circulating in the United States against those in India. Our sampling strategy might also be related; that is, participants were recruited from a list of participants and registrants for a previous climate change course and so we might expect this group of teachers to already have some kind of commitment to the idea of climate change.

Interesting challenges emerge between the certainty with which knowledge about climate change is held and taught, and teachers' descriptions of the limitations of their own knowledge. Not having enough information was a common refrain: '*the only barrier is getting correct information. And enough information, factual information*' (Ishana, female, Punjab, undergraduate, botany). Ishana's discussion highlights tensions between not having enough information while still holding beliefs with a certainty that requires behavioural changes of students:

> *We don't have enough facts. And in schools, it's okay to tell children climate change. Do this, put off electricity, don't let the water taps run, you know, don't have a shower, bath. All that is fine, but what will it mean ultimately if we don't do these little things, each one of us? I think it's important here and I don't think as teachers we have enough information and enough facts*.

In addition to not having enough information, teachers also described challenges with concepts about climate change that relied on mathematical modelling: '*because it has a little calculation and mathematical words and I can't visualize it all*' (Kabir, female, Telangana, postgraduate, biology). As Larisa (female, Assam, postgraduate, earth and environmental sciences) expressed it:

> *… when we talk about mathematical models, predictive science where we predict, we don't have any expertise there so that part would be something where I would like to know more and maybe if it is related to mathematics, that would be harder*.

A combination of these challenges—around mathematical complexity, and needing more information—recasts the certainty problematic outlined above. Beliefs about climate change are held with a very high degree of certainty, while their expertise about climate change seems to operate at a different level: '*climate and how that climate will change and how our future will be like, this kind of generalization I can say, but not very specifically*' (Kaamla, female, Tripura, undergraduate, earth and environmental sciences). The theme of generalisations and specifics also emerged strongly in the ways that teachers spoke about spatial dimensions, from global generalisations to local particulars.

SPACE AND CLIMATE CHANGE KNOWLEDGE

Climate change knowledge exists in a global space, conceptualised by these teachers as an interface between global and localised imaginaries. Distinctions between local and global aspects of knowledge about climate change were related to epistemology, and to the sources

of information available. In terms of epistemology, teachers described a contrast between generalised concepts related to an abstract global pattern or a symbol of climate change, such as glaciers melting in distant regions, and the experiences of teachers and students, particularly in terms of weather events they personally see, hear and feel. Suddenly, concepts discussed in workshops through global generalisations are made manifest: '*there's a lot of discussions and workshops on climate change happening. Then we realize that this climate change has an impact on our daily lives … Now is the manifestation of the climate change*' (Jash, male, Maharashtra, high school, biology).

Shared understandings of climate change as something universal, that would be faced by *everyone* and *everything*, was often emphasised. For example: '*Climate change is going to universally affect all citizens, all human beings, and all other life forms*' (Hem, male, Maharashtra, postgraduate, physics). Assumptions of the climate crisis as something universally known and experienced are challenged by Yusoff's (2018a) critique: *A billion black Anthropocenes or none*. Notions of a universal experience of climate change are also challenged from within the teachers' descriptions of their own positions of privilege:

> *I need to challenge myself rather than asking my Auto Wala or my house-help to stop using the fan, instead I should stop using the AC* [air conditioning]. *This is what it is. That is why I said per capita and look at the socio-economic thing and then look at the diverse nature of our people. Just like that, don't compare the number* per se *with some other developed country. This is what I, I need to put some work in order to make them understand and make them feel*.
>
> (Sonali, female, Kerala, postgraduate, humanities)

Sonali speaks to the chasm in climate change discourse, which has made action difficult or delayed: international climate negotiations, particularly in the context of India, foreground questions about justice and equity in relation to absolute or per capita commitments (Dubash et al., 2018). The importance of coexistence between a human '*we*' and '*the planet*' was deployed in Ishana's (female, Punjab, undergraduate, botany) argument for reflecting on and changing their own curriculum:

> *I think if we need to live and the planet needs to live then I need to throw some of the portion out and learn about climate change right? It is important*.

Abstract global concepts become intensely local and practical, to the extent that '*unless we understand what climate change is, we will not be able to handle many of the things in our day-to-day life*' (Sonali, female, Kerala, postgraduate, humanities). These '*things*' were often associated with changes to weather patterns, which for many teachers included increases in temperatures to the extent that whole seasons were transformed: '*When I realised that our weathers have been changing … it used to be very chill … But that is now totally gone you know. There is no sign of any kind of winter at all …*' (Nadee, female, Kamataka, undergraduate, social sciences). They also identified pedagogical opportunities offered by the local, embodied nature of knowledge about climate change, describing the challenges they faced when trying to teach students about the concept of climate change, and the ways in which their interest was captured when they *felt* it: '*I cannot get that much climate based unless and until* [the] *power goes off and students are complaining that it is hot and all*'. Others made use of local areas—'*the nearest place*'—for '*interactive play with the environment*' as a teaching resource that was seen as being better than conceptual knowledge about climate change:

> *Let higher education students take part in field studies—they can go to the nearest place where they can find nature that is supporting us every day, like*

> *waterfalls, water sources, lagoons, places where there are rivulets and how they are drying up. This kind of interactive play with the environment—this is better than the conceptual knowledge that we are giving them*.
>
> (Umaid, male, Bihar, postgraduate, electrical engineering)

In terms of sources of information about climate change, there was a frustration with the lack of local materials. Teachers' arguments echo critiques of the dominance of Anglo-American knowledge production and representation in geography (Hedding & Breetzke, 2021; Müller, 2021), and of the narrow representation of voices through media accounts (Smith et al., 2018). YouTube videos '*are interesting to watch but only … referring to developed countries like America. They need to give more knowledge about the Indian scenario*' (Tanirika, female, West Bengal, undergraduate, chemistry). Lack of local materials included availability in languages other than English:

> *You have more articles in the global scenario than in the local scenario. We really need to produce more article*[s], *or at least I'm not much aware of articles which are available in Tamil … it's actually a challenge to find in the local scenarios …*
>
> (Sonali, female, Kerala, postgraduate, humanities)

The contrast between attention given to global examples from elsewhere and local issues extended beyond the availability of teaching resources to media representations: '*The media does report a lot on it, but it seems to me that most of media reporters are connected … as if it's a foreign policy issue. Whereas climate change is very real and local also*' (Naksh, male, Maharashtra, postgraduate, chemistry), echoing the vast diversity of India's environments, cultures, risks and vulnerabilities (Mehta et al., 2022). The importance of place-specific aspects is similar to Manzo and Padfield's (2016) analysis. They contrast Malaysian media portrayals of climate change, capturing these differences as '*palm oil not polar bears*' (p. 460). Connecting education's role in equipping citizens with policymaking, some teachers described a dependency on policy borrowing, arguing for the importance of *translation* because of the distinctiveness of local situations:

> *We cannot forever be dependent on what policies are being talked about elsewhere in the world. Because India's problems are India's own problems. They come because of global change, but the ramifications of how they translate into Indian situations is also very local. So, we have to have our own solutions, and we have to have our own policymakers, but those policymakers will have to come out of our educational and research opportunity system. If those things are not in place, how will we generate them?*
>
> (Hem, male, Maharashtra, postgraduate, physics)

The role of education in the generation of future policymakers may be important, and the kinds of policies they develop will be, amongst other things, in response to and shaped by the kind of problem they believe climate change to be. The analysis now moves to consider the ways in which teachers understood this problem of climate change through a temporal lens; climate change as a long-term crisis and climate change as an immediate crisis.

TIME AND CLIMATE CHANGE

Climate change knowledge is structured as a future orientation, but positioned in terms of '*the urgency of now*'. *Now* is the moment, and these actions are overdue: '*it is high time now*'

(Larisa, female, Assam, postgraduate, earth and environmental sciences). Urgency is a key theme running through teachers' conceptions of climate change, linked to the ways in which arguments about the importance of climate change education are made through appeals to weighty matters of survival.

The future dimension permeating all descriptions of climate change was sometimes through a generalised 'forward' description, and at other times through a relational perspective towards generations, families and children:

> … *if we start acting on it right now, if* [we] *start understanding its consequences right now, the causes and the consequences right now at this stage, then probably you know, our kids and our students and our children, the future generation will be able to survive*.
>
> (Zara, female, Delhi, undergraduate, biochemistry)

Enfolding '*our students*' between '*our kids*' and '*our children*', all of which are then collected under the broader designation of the '*future generation*', makes explicit the deeply personal connections through which these relationships are envisaged. The future orientation is not an abstracted other, but a continuation of persons to whom teachers positions themselves temporally and relationally. Teaching about climate change was often linked to societal, public-serving ends: '*So whatever we read, whatever we study, is all for the public and for the society*' (Sadhil, male, Tamil Nadu, postgraduate, biology); reasons for teaching about and studying these issues that were prioritised beyond other aims, such as those restricted to individual benefits. Descriptions of the future orientation of climate change also touched on fundamental ontological questions about change and preservation:

> *… so that students can appreciate that everything that has been brought on this earth is not permanent, it is going to change and we have to preserve it…*
>
> (Vamil, female, Delhi, high school, biology)

In some accounts, the change was a future state—it is *going to* change—whereas for others there was first a looking back to the ways in which it has changed, and in these accounts the aim of climate change education is '*to ensure that the environment is not more damaged than how much it is already damaged*' by developing '*future sustainability leaders who can carry forward and save earth*' (Sayra, female, Maharashtra, high school, physics), '*recovering*' a previous state: '*So that the nature that is degrading day by day can recover and to sustain our life, I would say we must maintain coexist*[ence] *between human*[s] *and nature*' (Zala, female, Uttar Pradesh, undergraduate, earth and environmental sciences).

A small number of teachers described climate change in terms of a longer-term issue, framed as a future scenario. In this view, climate change involves '*very slow-moving changes … because if it's not fast changing, maybe it's a slow-changing phenomenon*' (Asmee). This slow-changing phenomenon is something that will lead to a decisive event—a disaster:

> *I don't think very honestly we understand … You know, we hear about the iceberg will be melting, water will be rising, but I don't think we can project ourselves that far to see what is the disaster that finally we will be facing*.
>
> (Ishana, female, Punjab, undergraduate, botany)

Here, the idea of projecting into a distant future is tied to an end point: '*finally we will be facing*'. There is a notion of climate change—or human experience of climate change—coming to a conclusion. Others described a conclusion in apocalyptic terms, which in this example are

potentially tempered by a critical association with the 'Y2K' movement which, despite alarming predictions, famously proved to be a non-event:

> *… we make a lot of jokes about how there's no point in studying right now because the world is going to end anyways. And a lot of fatalism that is coming in related to the upcoming, moving climate change. I mean I've heard people slightly older than me refer to it as the GenZ Y2K movement. There was this kind of mania that occurred with the Y2K movement in that generation apocalypse that might be coming soon. One student that I have, with no relation to what we discussed in class, by himself he wrote a journal article for the Forest Department journal. All departments have journals that they publish annually. And for that he wrote an article about nostalgia, nostalgia for a time without a climate crisis on the horizon.*
>
> (Rachit, male, Assam, primary)

As a longer-term issue, teachers foregrounded the impact on future generations:

> *It is a threat which has to be prevented for the future generation. So, this is not our problem actually, but still. So, something which has been there in the beginning, even though there has been so much of consciousness raising and awareness, I think the percentage has been raised. But the change has not been made and we can hope for the best that it will change.*
>
> (Nehrika, female, Mizoram, postgraduate, biology)

Defining climate change as '*not our problem actually*' is only possible from a position of privilege (Sultana, 2021a), and contrasts with the way in which most teachers described climate change as something that already affects their everyday lives.

Temporally, the main way in which teachers described climate change was as an immediate and urgent crisis: '*Climate change is very fast and the atmosphere, cloud precipitation and plant growth and vegetation, all things are affected*' (Nishu, male, Uttar Pradesh, undergraduate, earth and environmental sciences). Many used the phrase '*it is the need of the hour*' (Tanirika, female, West Bengal, undergraduate, chemistry) to capture this sense of urgency, and its priority amongst other competing agendas: '*We can follow this, we can do something … we can give some solution for climate change. And we need to. It is the need of the hour*' (Viti, female, Delhi, high school, social sciences). The contrast between these Indian teachers' beliefs about climate change and Busch's (2021) findings in an Australian context is striking. Many also described a change in priorities they have noticed, particularly between their own teacher training experiences and the present moment. For most, climate change was not given priority during their own education, whereas now they describe its priority in the highest and most urgent terms: '*when we have done our teachers' course this was not the need of the hour, now it is*' (Tanirika, female, West Bengal, undergraduate, chemistry). The urgency of the situation, and teachers' embodied engagement with it, was conveyed through the descriptions of emotion that teachers felt, and the ways in which their own efforts are portrayed. In this example, the effort is '*continuous*', '*a breathless action*':

> *… this has to be a continuous effort, a breathless action that has to be performed and I do it in this way, even if you ask any of children, even after 5 years they would say, yes, definitely I have spoken to them about climate extensively*

> *and that brings out my emotion for them. I was filled with emotion because it was the need of the time*.
>
> (Malika, female, West Bengal, undergraduate, earth and environmental sciences)

Another highly emotive metaphor used to describe the severity, urgency and rapid speed of climate change was '*like a bomb*':

> *Because if I say that there is a burning of these fossils and permafrost is thawing, we will talk about it like it is a bomb that is hidden at the moment and can explode any time. But how that incremental change in temperature every year is going to trigger that and then it will release carbon dioxide, methane into the atmosphere whose effects would be catastrophic. Can't even imagine how much impact it will cause and what will happen to the life on earth*.
>
> (Vamil, female, Kerala, high school, biology)

The combination of metaphors emphasising the immediacy and urgency of climate change and the certainty with which beliefs about climate change are held ratchets up the tension felt through the certainty problematic that geography must navigate as a central part of the discipline's contribution to public reasoning about climate change.

DISCUSSION: CERTAINTY AND CLIMATE CHANGE KNOWLEDGE

The *certainty problematic* summarises a key challenge facing public reasoning about climate change, and about the everyday decisions that teachers make as they select sources of information, shape metaphors and present ideas about climate change to their students. The problematic we outlined is summarised in two propositions, between which there is tension:

1. Students should be taught, against popular ideas about sceptical climate change denialism, that we can certainly hold the position that anthropogenic climate change is a real and urgent issue.
2. Students should be taught that there is an inherent uncertainty of all geographical knowledge, including knowledge about climate change, which is produced in particular ways with particular implications for the ways in which it constructs how we know 'the climate'.

This problematic highlights the certainty of these teachers' beliefs about climate change, and the challenge of attending to the second aspect: creating space to discuss the uncertainty of knowledge. International negotiations around accountability—historic, per capita and so on—are echoed in these teachers' accounts. Expanding the diversity of explanations might be stimulated by appreciating and giving attention to the idea that 'there is a geography of all geographical knowledge' (Livingstone, 2019, p. 461), including through the ways in which the nature of disciplines (Puttick & Cullinane, 2021) might be made more explicit. There are clear tensions between the certainty of teachers' beliefs about climate change, the connections with extreme weather events and the continuing complexity around technical discussion of uncertainty. The teachers' critique of the Anglo-American dominance of knowledge production about climate change also offers generative avenues through which to address the certainty problematic, because of the ways in which reframing questions

about certainty and uncertainty moves debates from generalised, algorithmically produced global averages to those centring locally specific, contextually rich insights (Spencer & Lane, 2017).

Bringing these frameworks and provocations into dialogue with the voices of teachers in India that we have presented, there is a clear sense in which the expansiveness of the teachers' descriptions about climate change already speak to the multi-disciplinary and political dimensions of climate change. There are common beliefs about the importance of climate change, its complexity and the challenge facing those seeking to take human dimensions of environmental change seriously. Across the findings there was a surprising consistency in beliefs about climate change knowledge across this diverse group of teachers. The energy, enthusiasm, commitment and seriousness with which climate change education is engaged with by these teachers offers exciting potential for transforming climate change education in ways that make substantial impacts on the quality of public reasoning. These discussions also point to the potential for geography to help us understand and contribute to education through multiple fields associated with geography and education, in ways that are not narrowly confined to people working in geography departments but across the interdisciplinary areas associated with climate change. The very high degree of certainty with which teachers' beliefs about climate change are shown to be held in our accounts highlights the need for reflecting on the certainty problematic: how might productive, generative intersections and shared aims across these fields connect to positively contribute to public reasoning about climate change? How might climate change education develop more locally sensitive, contextually rich and intellectually plural accounts that meaningfully inform, transform and empower citizens in their everyday lives? Listening carefully to people engaged with these issues, particularly outside of an Anglo-American sphere, is an important aspect of this. The actions of teachers highlight the potential for individuals to reshape or disrupt contested knowledge across space (global to local lenses), time (future imaginaries to the present) and knowledge hierarchies (basic to complex). The metaphors through which these teachers understand and explain climate change knowledges, particularly in terms of conceptualising climate change *as crisis*, raise multiple challenging questions about (un)certainty and education's potential contributions to public reasoning.

CONCLUSION

Our aim in this paper was to explore the discourses about climate change that are being constructed by teachers in India. Through analysis of in-depth interviews with 48 teachers in India from a range of states and phases of education, we have presented the teachers' descriptions of their everyday actions and decisions related to their teaching of climate change. The understanding of these discourses we have presented as multiple and complex, yet with areas of strong agreement across individuals who work in very different contexts. The shared sense of absolute certainty about climate change, the framing of crisis, immediacy and urgency were all deeply felt. Analysis of these shared aspects also reveals tensions amid the epistemological, temporal and spatial complexity of climate change. The heuristic through which these tensions might be explored—the certainty problematic—was offered as a tool to help theorise the nature of climate change knowledge development within educational spaces. Particularly where there are moves towards normative positions about what students ought to do, the heuristic opens space to consider the relationships and potential contradictions between teaching certainty while also representing the inherently uncertain nature of climate change knowledge. Teachers' interactions with climate change knowledge both reproduce global climate change knowledge while also providing the mechanism for subverting, expanding and reinterpreting it as they recontextualise, integrate, amend and apply it into their own localities and educational

spaces. Our application of the certainty problematic highlights the dominance of certainty about climate change, against a lack of attention to the inherent *un*certainty of scientific knowledge. Teachers have a key role to play in addressing arguments about the complex ways in which climate change might be engaged from political and ethical positions. What happens in these classrooms has profound implications for the nature of public reasoning, and opens space for climate change education to make a positive contribution to public reason with the ultimate aim of addressing issues of climate justice.

The ways in which these teachers speak of a desire to know more and to make a difference is expressed in ambitious terms about the future of humanity, and following this we want to highlight the need, opportunity and potential for engaging with public reasoning about climate change in all of its epistemological, political, ethical, spatial, temporal and normative dimensions.

This research contributes to work that has paid little attention to teachers' everyday practices in climate change discourses, and which has been dominated by Global North perspectives. The co-creation of local climate change education resources, and making these more visible through online search engines, is a key site for future collaborations. Future research might also extend this analysis of teachers' reports to include observational and ethnographic insights into teachers' work with climate change knowledges. Longitudinal aspects would also offer scope for exploring the ways in which the cycle and rhythms of the academic year impact on and are related to teachers' thinking about climate change education. Also, particularly considering Hitchings' (2010) attention to the importance of seasonality, a longitudinal approach would offer scope to give attention to the ways in which different seasons highlight and foreground teachers' different experiences of navigating the relationships between embodied experiences of the weather and conceptualisations of longer-term climatic trends. Future work might include in-depth analyses of teachers' phase of education, area of subject expertise and place, which would make a valuable contribution to our understandings of climate change education and how teachers' professional development might offer locally specific, place-based support. Climate change is the '*need of the hour*', which this work understands as not only involving material impacts and processes, but also important epistemological, collaborative needs through which education might contribute to public reasoning about climate change.

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The authors declare no conflict of interest.

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Research data are not shared.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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