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Responsibilities and practices of mathematics teacher educators in relation to the new climatic regime: “It’s a choice I make.”

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The world has entered a new climatic regime, in which past regularities no longer hold. We are likely heading into several decades in which drought, floods, harvest failure and all the political and social upheaval these will cause become the norm. In such a context, this paper asks, what are the responsibilities and practices of mathematics teacher educators? I adopt a socio-ecological perspective in addressing that question. The data comes from narrative interviews with 9 mathematics teacher educators in the UK. The aim of the interviews was to uncover current practices which have been influenced by the new climatic regime. The findings indicate a strong desire to bring issues of climate justice into teacher education programmes and a range of systemic barriers to this happening, including time and curriculum constraints. A desire for more opportunities for mathematics teacher educators to meet and share resources and approaches was felt by many.

Keywords: Mathematics teacher educators, new climatic regime, teacher education practices.

The new climatic regime

The world has entered a new climatic regime (Latour, 2017) in which past regularities of seasons and rainfall are irreparably disrupted. We are already seeing the impact of this new regime on the frequency of extreme weather events, including droughts and floods. It is likely food shortages, political upheaval and wars will follow, along with the forced mass migrations these will necessitate. In such a context, this paper is driven by the question: what are the responsibilities and practices of mathematics teacher educators (MTEs)? Do we continue as if nothing has happened – business as usual? And, if that option seems impossibly utopian, what else can be done? Through interviews with a group of MTEs in England, I explore the influence of the new climatic regime on the roles and practices of MTEs (what they do), with a view to prompting and sharing spaces for change.

In the next section I offer a brief review of the small literature on mathematics education and climate change and some reviews of the broader field of climate change education (i.e., education practices which aim to support student understanding of climate change and, in some cases, inspire action). I then set out the socio-ecological perspective of this research, and the methodology of the study. The data from the interviews follows and then a concluding section drawing out implications.

Past research on mathematics teacher education and climate change

Past reviews have found little work within mathematics education that addresses questions of the living world (Coles & Boylan, 2017), and even less within the specific area of mathematics teacher education. Across two special issues which had a focus on linking mathematics education to questions of ecology (Research in Mathematics Education, vol 24(2), 2022; Philosophy of Mathematics Education Journal, vol 32, 2017) only one article looked specifically at mathematics teacher education (Helliwell & Ng, 2022). Helliwell and Ng (2022) reported on the use of speculative fiction

as a tool for engaging prospective teachers in England and Hong Kong, in both discussing climate issues across their different contexts, and in thinking through possible futures for themselves.

However, the lack of attention within mathematics education to issues of climate and sustainability is a situation which appears to be changing, as signalled, for example, by the International Commission on Mathematics Instruction (ICMI), holding a symposium on “Mathematics Education and the Socio-Ecological” in March 2023. Furthermore, the theme of the Annual Conference of the International Group for the Psychology of Mathematics Education (PME) in 2023 is, “Mathematics Education for Global Sustainability”. CERME Working Group 27 is one that has an explicit strand linked to global challenges. In Coles and Helliwell (2023), in an article built from a CERME12 paper, we reported on work taking place at the University of Bristol (UK), on a teacher education course, to support prospective teachers in linking their subject teaching of mathematics to global challenges (including, but not limited to, climate change). The work at Bristol has the label “Green Apple Project”, taken from the name of the initial funding. One finding (Coles & Helliwell, 2023) was that, alongside a rise in prominence of the Green Apple project on the course (e.g., the project is mentioned in advertising and is seen as a unique selling point), activities within the project continue to have a “one-off” feel, both in the practices of the prospective teachers and in the practices of the MTEs.

Given these findings, it is significant to explore what other practices of MTEs are there, across the UK, to learn from others and to support a sharing of ways in which MTEs can create spaces for prospective teachers to explore possibilities for their own teaching of mathematics, especially given the importance of mathematics in modelling, predicting and communicating climate change.

In undertaking this study, I have been able to draw on three reviews of the broader scope of climate change education research, in recent years (Varela-Losada et al., 2016; Monroe et al., 2019; Rousell & Cutter-Mackenzie-Knowles, 2020). Varela-Losada et al. (2016) summarise the objective of climate change education to be “the development of action competence, based on reflection, critical thinking and student participation” (p. 392). Reflection and critical thinking are central to any teacher education course and so, at a process level, there feels to be a potential synergy here between the aims of climate change education and teacher education. Monroe et al. (2019) identified four themes relevant to effective climate change education: (1) deliberative discussion; (2) interactions with Scientists; (3) addressing misconceptions; (4) school and community projects (p. 801). Interactions with Scientists was a theme Coles and Helliwell (2023) found to be effective also, in working with a mathematics teacher to develop tasks with a climate change focus. And, thirdly, Rousell and Cutter-Mackenzie-Knowles (2020) distinguish approaches to climate change education which are knowledge-based, from those which are interdisciplinary, affect-driven and experiential. Their review pointed to the predominance of knowledge-based approaches and called for more of the latter.

The three reviews above point to some possibilities for future work within mathematics teacher education, i.e., using climate change as a context for reflection and critical thinking, engaging Scientists to interact with prospective mathematics teachers, and supporting prospective mathematics teachers to engage in interdisciplinary, affect-driven and experiential learning, in relation to climate change. In approaching this study, I was interested to see the extent to which any of these elements of practice might be present in the work MTEs report as taking place in the UK.

A socio-ecological practice

Philosophically, I approach this study informed by socio-ecological practices (Coles, 2022; Coles et al., 2022). Crucially, within socio-ecology, climate change (which might be considered an ecological issue) and climate justice (which might be considered a socio-political issue) cannot be separated. For example, questions around the effects of climate change must involve questions around the differential effects of disruption, the historical causes of pollution and the rights of marginalised groups to reparations for loss and damages, as a result of climate change (i.e., climate justice).

A socio-ecological practice of mathematics education is one that aims not to take ecology as a fixed background for socio-political concerns. While aiming to draw greater attention to the role of the ecological than has happened in the past, such practices also draw inspiration from past work in ethnomathematics, critical mathematics education, Indigenous knowing and, more broadly, process and relationally focused philosophies. One key commitment, within a socio-ecological practice, is to move away from viewing the individual as the unit of learning, development or evolution (Coles et al., 2022). Rather it is relations and relationships which learn, develop and evolve. A second commitment is towards a dialogic ethics (Barwell et al., 2022), in which there is a recognition of the significance of the “other”, in that, we become subjects through recognition by others (Levinas, 2011). It is through being recognised that we come to assume responsibility. A dialogic ethics therefore reverses the more standard notion that we are individual subjects first, before coming into relation with others. A dialogic ethics informed the methodology, in wanting the interviews to offer an opportunity for emergent thoughts to be recognised (for interviewer and interviewee).

Interview methodology

For this research, interviews were conducted with 9 MTEs in the UK. The sample was designed to offer a snapshot of the practices of MTEs who are likely to be engaged in activity around climate change. The idea here was to find out about what possibilities do exist and to highlight spaces and opportunities. The Association of Mathematics Education Teachers (AMET) is a UK-wide organisation and through their contacts, participants were sought. Of the 9 participants, 2 taught primary prospective teachers (primary schools in the UK take children from age 4 to 11) and 7 taught secondary prospective teachers (secondary schools take children from age 11 to 18).

The conduct of the interviews was influenced by practices of narrative interviewing, and a set of principles articulated by Petitmengen (2006) and extended in Brown and Coles (2019). These principles or protocols are: (1) stabilising attention (reformulating what is said, asking questions that bring attention back to experience); (2) turning the attention from “what” to “how” (never “why”); (3) moving from a general representation to a singular experience (encouraging participants to talk out of experience, about the detail of that experience); (4) getting to new category labels (potentially supporting participants to articulate any new awarenesses or patterns arising from the interview process). These protocols are a part of my practice as an interviewer and informed the interviews, even though the interviews for this project did not involve the deep exploration of experience typical in narrative interviews and were also shorter than typical narrative interviews, at 30-40 minutes. There were five specific questions I asked, (not always asked in precisely the same way): “do you address questions around climate or climate justice in your teacher education course?” (following up with

requests for specific examples, linking to protocol 3); “are there any barriers to doing this?”; “are there things that would help, as a MTE, addressing climate issues?”; “how do you think the connections between local and global issues?”; and “how do you think about your role, as a MTE, in relation to climate issues?” (these last two linking to protocol 2). A draft version of this article was sent to all nine participants for comment. Places and names have all been anonymized and attempts made not to include details that are likely to identify particular teacher education programmes.

The approach to analysis was to make an initial tabulation of responses from the 9 participants to the 5 core questions. The table contained quotations, selected by me, on the basis of the discussion above, i.e., looking for key points made in relation to socio-ecological practices and other practices mentioned in the literature. From this table the approach to analysis was one of searching for connecting patterns (Bateson, 1972) and it is those patterns, with representative examples, which I report in the next section. The transcripts have been cleaned of repetitions and hesitations, with the following conventions: [...] indicates some text deleted for ease of reading; gender references have changed to “they” or “them” to support anonymity; single letters are used to denote the different MTE voices; [text] indicates an editorial change to make language accessible to an international readership.

Interview findings

I report on the interview responses, grouped into three sections relating to the questions asked (responsibilities of MTEs, current practices of MTEs, enablers and barriers to a focus on climate justice). Within each section, I report on patterns in responses, identified as described above. Where there are links to the recommendations from climate change education literature, these are in bold (i.e., reflection and critical thinking; engaging Scientists; supporting interdisciplinary, affect-driven and experiential learning) and they are summarised in the conclusion.

Responsibilities of MTEs

MTEs were unanimous in seeing part of their role as having some responsibility towards addressing questions of climate change, even if, in some cases, there was a perception of having little space to enact that responsibility. As mentioned above, it is important, in relation to this finding, to keep in mind the self-selected nature of the sample (i.e., these were all MTEs who showed an interest in climate issues). One MTE commented, “it does seem to me really important that [prospective teachers] have gone through a process of being challenged to engage with their own sense of values [...] and what's significant” (J). Another MTE viewed their role as supporting prospective teachers to be change-makers in the departments in which they work, “whether we are talking about racial inequalities, social inequalities, climate change, justice, the work is being done at the ground level. Teachers in school, our [prospective] teachers, and they are the ones who are facing the children on a day-to-day basis, the next generation, that's where I think the power is to change” (H). Another MTE saw their responsibilities in terms of **affective** issues, “I think one of the biggest messages I tried to give [prospective teachers] is the most important thing you can be, is kind” (M). This MTE also saw their role as, “giving people skills which enable them to interrogate, you know, information and make some sense of it” (M). Themes across the responses were about supporting prospective teachers' critical engagement with justice issues, supporting **critical self-reflection**, and supporting a **felt awareness** of the needs of school students.

Current practices of MTEs

In terms of current practices of MTEs which address questions of climate justice, there was a clear divide between primary and secondary teacher education courses. The two primary MTEs (A and G) both reported that, despite intentions they may have, they are not able to include questions of climate change/climate justice in a mathematics context. One MTE (G) reported they have 12 sessions on mathematics with prospective teachers, in which to cover all mathematics-specific education content. For both primary MTEs, there were times their courses made links to wider societal issues (in both cases framed around social justice, not climate justice), and these were done in the context of the humanities. In contrast, all 7 secondary MTEs reported running, or planning, mathematics subject sessions with a focus on wider justice (social, racial, climate) issues. One MTE reported on **drawing on their own experiences** as a teacher, where “the children were really open and receptive to talking about issues to do with pollution, child labour” and drawing on such experiences in their role as a MTE, “I always wanted to include these ideas in my sessions, because I’d seen how much the children in front of me had engaged in the material, so I always included ideas on racial justice, and more recently on climate justice issues” (H). The same MTE made use of a University wide focus on researching air pollution, to link in to teacher education sessions and tasks. **Personal experiences**, as mentioned by H, were also significant for N, whose past climate activism was linked to “humanist” values they were aware of bringing to their teaching of prospective mathematics teachers.

One MTE (R) mentioned the school student “strikes” (inspired by Greta Thunberg) as being a turning point for them in terms of bringing climate issues into their teaching, stemming from witnessing the powerful effect on prospective teachers of joining the student marches. At one University, a one-day conference on “green” issues takes place every year, which supports prospective teachers in considering their own roles and responsibilities in school, along with a role of “climate ambassador” on the course (R, S). At this conference (which is **open to all subjects** within the secondary teacher education course) there are outside speakers and also prospective teachers report to each other on work they have done in their classrooms. At this University, R reported there are three MTEs who all feel passionately about the environment and about making environmental links in their teacher.

Barriers and enablers to a focus on climate justice

There was again a primary/secondary difference in terms of perceptions of barriers to including climate justice related issues in their teacher education course. For both primary colleagues, the constraints of the teacher education curriculum and the school curriculum were barriers. One MTE also referred to the role of school-based mentors, “it’s hard getting the mentors to be relaxed enough to let [prospective teachers] take a bit of ownership for some of the work [...] I almost think it's the um lack of confidence in the mentors [...] in the subject” (G). In other words, this MTE is reporting that even if they were able to do more climate-related work on their teacher education course, the prospective teachers would struggle to be able to try out any novel tasks in schools.

Secondary MTEs did also mention the culture in schools as a potential barrier, in the sense of there being so much to learn, as a prospective teacher, in order to “feel safe” (M), or, simply, “to get children into a classroom sat down and doing some mathematics” (J); another perspective was

mention of “systemic inertia” (N) in the school system, which made change difficult. The issue of lack of time (echoing primary colleagues’ views) was also mentioned by secondary MTEs (N, S).

One issue raised by several MTEs was the complexity of addressing issues which could be seen as political or controversial. The concerns ranged from not wanting to be seen to be indoctrinating others, to feeling that more important than highlighting climate justice, was the imperative for prospective teachers to develop the skills to engage in the process of learning about teaching, and to be supported in identifying their own priorities (J). One MTE put this issue as, “It feels a bit like um, we’re trying to change what happens in schools via trainee teachers, [...] it almost feels like the change has to come from schools [...] [being a MTE is] an odd role [...] I’ve talked about my beliefs and how important they are, but it has to have this pragmatic approach where we are preparing teachers to be professionals in the system as it exists now”. For this MTE, a balance needs to be struck between provoking change in schools and supporting prospective teachers to be successful in schools now.

There were significant differences in University culture, in relation to promoting attention to questions of climate justice. At one extreme, one MTE reported, “I’ve been kind of, I suppose, cautioned almost by [...] my line manager about being too much of [...] an angry old [person]” (M). At the other extreme, a MTE reported their University wanting to set itself up as a leader of the field, in terms of a focus on ecology. Somewhere in the middle, perhaps, one MTE commented, “I just feel from my point of view **it’s a choice I make**. I could either choose to present other mathematics to them, or data to them, or I could choose to present [...] climate justice [...] racial justice [...]” (H). Interestingly, despite, in England, a recently mandated curriculum for initial teacher education (which makes no mention of social or ecological justice), this was not raised by MTEs as a constraint.

Looking forward, there were a range of suggestions as to what might help MTEs bring greater emphasis to the implications of the new climatic regime. The need for school curriculum change was felt across primary and secondary colleagues and “reducing the assessment expectations in primary” (G), i.e., the need for teachers to be tracking and reporting on student progress towards national benchmarks in mathematics. One MTE suggested **a push for curriculum change** was coming from prospective teachers themselves, who are “saying there’s a real need, and we want to do this work” (H). There was a request for more resources, again felt across primary and secondary MTEs, for example, “data sets that were aimed at primary children” (A), and a feeling of needing more knowledge about climate issues, to bring such issues into their teaching effectively (F, S). A response, across several MTEs, was a desire for more connections with other MTEs working on similar issues, for “discussions amongst maths education tutors, sharing of things we have tried” (M). And, where those discussions are taking place in a University, a comment that, “I’ve been helped massively by the fact that I’m very far from being a lone voice” (J).

Conclusion

This paper set out to investigate the views of MTEs about their roles and practices in relation to engaging prospective mathematics teachers in issues arising from the new climatic regime. There has been little past work on this question. Past reviews of climate change education more broadly suggest there may be some synergies in terms of climate change education and teacher education, both requiring critical reflection. Findings from the interviews paint a mixed and complex picture, even

within a small sample of 9 MTEs. While there was unanimous agreement about viewing the MTE role as having some responsibility in relation to raising questions of, say, climate justice (“it’s a choice I make”, (H)), there were differences in terms of the extent to which those responsibilities could be enacted. Barriers to fulfilling the kinds of roles MTEs might like to take up included a school curriculum and assessment regime that was experienced as lacking space for such work, and this was particularly apparent within primary teacher education (compared to secondary).

Some of the work being done by MTEs fits with recommendations in the wider literature, i.e., to be focused on critical reflection, to link to affect and to build on lived experience. There was also some inter-disciplinary work taking place and discussion of curriculum change. The idea of linking with Scientists appears not to be taking place, across the practices of the MTEs interviewed and engaging in such links is a recommendation for further development and research. Mathematics has a particular importance in terms of supporting students and teachers to make sense of climate change and climate models and hence there is ample potential for mathematics to be linked to other sciences or broader inter-disciplinary work, for instance, projects involving scientific data collection and analysis.

The role of the University context emerges as significant. Some MTEs feel impelled, by the context of their University, to explore was of engaging in questions of climate justice, others have been warned by line managers to avoid putting across their own political views. Several University teacher education courses do have a strong overarching theme of social justice or inclusion, so it appears space would exist for a teacher education course to make climate justice a present and over-arching theme. The role of colleagues who share convictions around the climate was similarly significant.

Looking forward, there is a clear desire for more opportunities for MTEs to share approaches and resources. I suggest that creating such spaces is a current and urgent responsibility of the mathematics education research community. A need is apparent for more resources for MTEs which have a climate focus and also mechanisms by which MTEs can become more informed about climate issues. However, there are complexities to be navigated, particularly in the way in which some MTEs felt a hesitancy in bringing their own personal and political convictions to their teaching. Interestingly, it appears that MTEs did not feel that tension in relation to questions of social justice, or inclusion. Social justice, as an issue, appears “safe” to discuss and emphasise, in a way that climate justice is not. Questions of climate justice perhaps speak to the very foundations or organisation of capitalist society and hence might be seen as a threat. (In England, the government has banned the use of any resources in schools which come from organisations judged as “extreme”, which includes any organisation seen as anti-capitalist). A further complexity to emerge is the tension, for a MTE, between pushing any particular aims or ends for schooling (such as climate justice) and supporting prospective teachers to develop their own convictions. In other words, for MTEs who take a “meta” perspective on their role (e.g., that their focus is on supporting the process of learning for prospective teachers, not what they learn) then there is a tension if, at the same time, there is a particular issue (such as climate justice) which they want prospective teachers to become passionate about.

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