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Leading professional learning for sustainability in geography education through curriculum design

Purpose: International and national education policy identifies the need for young people to develop knowledge and understanding of sustainability and to use this knowledge for positive action. This paper reflects on a larger curriculum investigation project that used the Curriculum Design Coherence (CDC) Model with in-service teachers as a professional learning framework to engage their learners with sustainability in geography education, this paper outlines the diffractive insights of two teacher educators, making sense of our contribution to the project in order to explicitly discern our roles.

Design/method/approach: Our enquiry is situated within the participatory paradigm in which we recognise the roles of teachers and teacher educators are entangled in the co-production of knowledge.

Findings: We find that curriculum design, with its focus on disciplinary knowledge is an important aspect of curriculum coherence in relation to the concept of sustainability. Significantly informed collaboration between teachers and teacher educators enriches professional learning through engagement with both research materials and conceptually informed dialogues.

Originality: This paper draws on a posthumanist philosophy and a diffractive methodology to make explicit the epistemic role of the teacher educator in a climate change and sustainability education project.

Practical implications: We conclude that more research on the role of teacher knowledge with practitioners, is needed to enable professional empowerment so that in turn young people, can become informed and critical citizens.

Key words: sustainability; curriculum design; professional judgement; epistemic coherence; collaborative professionalism.

Article classification: Research paper

Introduction

Sustainability and climate change education (SCCE) is increasingly seen as a vital component of our response to the ongoing environmental crisis (Reid, 2019). SCCE has the potential to make an important contribution to empowering pupils and their teachers to be critical and informed citizens. This paper focuses on the second phase of a curriculum design research project which had exactly this ambition. The project explored how the Curriculum Design Coherence (CDC) model (Rata, 2019) could be used as an educative framework to support primary teachers and pupils (aged 7–11) in England to develop their appreciation of the concept of sustainability (Swift, 2023, Swift *et al.*, 2024). We understood sustainability education to be that which ‘supports citizens of today to live in ways that do not cause environmental harm, rather to live environmentally restorative lives that maximise opportunities for life on a healthy planet now and in the future’ (Greer *et al.*, 2023, p. 7). When we evaluated the first phase of the project, the curriculum sequences created by the project teachers, our attention was drawn to their recognition that we, as teacher educators (TEs), had contributed a different relationship to knowledge about both SCCE and curriculum design to that which they, as classroom-based teacher-researchers possessed. The project teachers, as co-researchers, were unequivocal that this epistemological relationship was pivotal in the positive impact that the project had on their curriculum design practices in SCCE. Consequently, as TEs responsible for the professional development of experienced teacher colleagues, we were motivated to embark on a self-study to make explicit the ways in which our knowledge was different to that of our teacher colleagues and to discern the impact that this had on their curriculum design capabilities. We were eager to draw on a methodological approach that enabled us to attend to how our epistemic knowledge and that of our co-researcher colleagues interrupted and transformed professional learning. This focus contrasts with studies that foreground the role of TEs as transmitters of research.

This paper shares insights from what became the second, and previously unanticipated phase of our project, one that focused on how our credibility as TEs within the project was largely based on our relationship with knowledge and not simply on our social position as ‘knowers’. In order to pursue this line of enquiry we drew on a social realist recognition of knowledge as an object of study so that the effects that different forms of knowledge have on intellectual and educational practices (Maton and Moore, 2009) can be made visible and therefore studied.

During the initial project phase, the CDC framework was used to support the process of curriculum design, positioning both ourselves and the teachers as co-researchers. We wanted to find a mechanism which would enable us to continue this collaborative ethos into the project’s second phase. Our attention was drawn to a posthumanist philosophy and a diffractive methodology to analyse our epistemic endeavours. Posthumanism scrutinises the significance of interconnectedness within complex systems. Diffraction as a methodology was attractive as it enabled us to pay attention to the ways in which our knowledge as TEs, interrupted and interfered with that of the teachers and vice versa. This is a very different approach to that of reflection, which implies mirroring or the replication or reproduction of transmitted knowledge. Our study is diffractive as we used the themes generated from our data to analyse the discourses, reading and re-reading the dialogues to explore the significance of knowledge as an object of study. A diffraction pattern ‘does not map where differences appear, but rather maps where the *effects* of differences appear’ (Harroway, 1992, p. 32, original emphasis).

Our research data were collected from the qualitative survey responses of our three primary teacher researcher colleagues and a series of four diffractive conversations between ourselves as two TEs (Diane as project co-ordinator and Emma as project evaluator). Whilst our study is situated in England, we recognise that teacher education is also at a critical

juncture in other jurisdictions, including in the United States (Darling-Hammond, 2020), across Europe (Flores, 2023) and in New Zealand (McPhail, 2021). We therefore hope to make a modest contribution to the literature that makes visible the productive impact of the work of TEs (Lofthouse, 2023; Knight, 2024) and challenges the transactional instrumentalism evident in policy documentation (Hordern and Brooks, 2024). First, we include a brief literature review that relates to our research question: How can TEs credibly lead professional learning for sustainability in primary education through a focus on geography? Next, we share how our data analysis led us to identify four key themes: the significance of conceptualisations of sustainability, a focus on the effects of different forms of knowledge in curriculum design, teachers' epistemic agency, and the role of coherence in SCCE. We then discuss our findings in relation to these themes before offering conclusions concerning the significance of TEs as epistemic agents in SCCE.

Literature review

Education policy makers and practitioners worldwide recognise the pressing need for young people to develop and apply their knowledge and understanding of sustainability for positive action. Despite this compelling demand, enabling such educative opportunities is both challenging and complex. The identification of meaningful and educative curriculum design frameworks which consider the complex and polysemic nature of sustainability and the provision of quality teacher education that enhances SCCE (Rushton *et al.*, 2023) represents one such challenge.

A recent analysis of policy documentation in relation to SCCE states that educational contributions were overlooked in favour of economically related solutions to the climate crisis (Greer *et al.*, 2021). Such prioritisation foregrounds particular forms of knowledge and particular knowers. Economic framing 'downplays the role of responsibility, ethics and values in sustainability and climate change education' (Dunlop and Rushton, 2022, p. 1093),

emphasising the discourses of economic growth and stifling concerns around the climate crisis. Education and the climate crisis are not linked in such documentation, rendering educationalists inert and limiting their potential to contribute to alternative conceptualisations.

The dominance of an economically-driven framing was also found to be prevalent in Department for Education's (DfE, 2022a) 'Sustainability and climate change strategy for schools and Children's Services'. This strategy presents sustainability education as a response to the problem of young people's worries about climate change. Such articulations contrast with the more expansive expressions embodied in UNESCO's (2024) Greening Education Partnership (GEP) which takes a holistic approach to tackling climate crisis with education plying a key role. The partnership highlights four areas of transformative education, inter-linking schools, the curriculum, communities and teacher training and education systems' capacities so as to increase coherence and reduce fragmentation (UNESCO, 2024). The focus on coherence and connection and a transformational approach for climate empowerment represents a significant shift from the transactional and translational ways in which knowledge and knowers are currently positioned in policy documentation in England.

Transactional approaches include those in which professional learning is considered as a method of 'preparing teachers to implement reforms' (Kennedy, 2005, p. 248). In relation to SCCE there are dilemmas associated with such a perspective. Research by Drewes *et al.* (2018) demonstrates that teachers need agency to grapple with complex information associated with SCCE in order to bring such essential content into their curriculum designs in meaningful and relevant way for their pupils. It is therefore important to 'call out teachers' CPD which assumes teachers cannot "cope" with complexity or nuance' (Lofthouse, 2023, n.p.). This matters when policies represent knowledge as being dependent on anthropocentric ideology that has, promulgated an objective form of sustainability which appears 'exempt

from values, beliefs and norms’ (Dedeoğlu and Zampaki, 2023, p. 33). To future-proof human existence in this world, we would therefore do well to reposition ourselves within Earth’s complex ecological web and foreground human and non-human relationships through a posthuman lens of ‘humility, kinship and care’ (Braidotti, 2017, p. 7).

In contrast, transformative professional development supports teachers ‘in contributing to shaping educational policy and practice’ (Kennedy, 2005, p. 248). A central aim is ‘the transformation of society through the contribution it makes to the formation of human beings who think critically, act ethically and seek justice throughout their lives’ (Mockler, 2005, p. 733). In order to underpin this alternative conception of professional learning in SCCE a more expansive evidence base is needed. Yet, the research which informs the current DfE’s strategy is ‘econometric-based analysis’, dependent on large-scale projects and standardised measures of teacher effectiveness (Tatto, 2021, p. 27). These projects prioritise a ‘linear processual epistemic basis that is represented by a belief that doing A will lead to B and then C etc.’ (Evans, 2023, p. 4). This positions teachers as instrumental deliverers of pre-determined curriculum sequences, with teaching reduced to a technical endeavour dependent on protocols rather than being a reasoning profession. As Stenhouse (1975, p. 24) recognised ‘it seems odd to attempt to minimise the use of the most expensive resource in the school’, for it is teachers who can bring about coherent epistemic access for their pupils.

The curriculum design approach foregrounded in England’s current education strategy promotes material crafted by Oak National Academy - an ‘arms-length national curriculum body’ (DfE, 2022b, p. 27) commissioned to develop SCCE curriculum resources (DfE, 2023, p. 4). This approach could legitimise ‘widespread perceptions of curriculum as (merely) an official test designed by government official authorities to be faithfully implemented and passively “received” in schools’ (Priestley *et al.*, 2021, p. 1). Arguably this focus on

curriculum alignment rather than coherence limits teachers' epistemic agency in SCCE.

Coherence is understood to mean 'the construction of reasoned, logical and examined selections of knowledge, specialised, organised and sequenced through disciplined epistemic means, in order to effect meaningful connections' (Swift, 2023, p. 8). Teachers need access to knowledge about knowledge to grapple with coherent curriculum design solutions. This is challenging to enable in an educational landscape where 'politics, economics and ideology has driven many government initiatives rather than knowledge derived from scholarship in teacher education' (Loughran and Mentor, 2019, p. 219). It is therefore significant that 'generative and transformative teacher research sit[s] alongside structures and cultures of compliance' (Tatto, 2021, p. 28) so that we can 'call into question the powerful influence that market-oriented analysis exerts on policy-makers' (p. 28) and increase teacher agency in SCCE.

Teacher Agency in SCCE

The models of teachers as technicians and teachers as craftworkers are insufficient if teachers are to critically engage with sources of information for SCCE. Underpinning this conception is a reductive view of young people as material to be moulded, rather than minds to be educated (Orchard and Winch, 2015). The preferable model, that of teachers as epistemic agents, has its roots in transformative teacher education which seeks to develop teachers' systematic knowledge in research-rich environments in order that teachers have a conceptual framework to draw upon to analyse curriculum design. The OECD (2019, n.p.) recognise that 'the opportunity to acquire disciplinary knowledge is also fundamental to equity', this is because disciplinary knowledge offers a structure to cohere, connect and sequence other forms of knowledge. If such structures are not evident in policy, then it is essential that the work of TEs who 'connect everyday practice with wider forms of knowledge' (Knight, 2024, p. 2) is made explicit for its transformative effects.

TEs enabling coherent curriculum conversations in SCCE

TEs are expected to engage in a multitude of roles (White *et al.*, 2020; Rawlings Smith and Rushton, 2023), many of which are visible, such as the observation of colleagues to support their professional learning and development. Often such endeavours focus on contextual factors, resulting in descriptions of practices rather than accessing conceptual understandings which can be drawn upon to evaluate the coherence of actions in relation to their professional purposes. Consequently, TEs' work can be under-appreciated, because of 'the uncertain, ill-defined and under-valued nature of professional knowledge' (Vanassche *et al.*, 2019, p. 479). Previously the role of TEs has been analysed for their social relations rather than for the epistemic consequences of their work (Ellis *et al.*, 2020; Mena *et al.*, 2016). Such analysis prioritises the observable or surface elements of TEs' work, meaning that professional support for TEs is less likely to engage with the nature of knowledge as an 'objective product' (Rata, 2021). Such an omission is potentially problematic as it is 'engagement with the generalising concepts and materialised content found in disciplinary-derived knowledge which builds cognitive thinking, the permanent change in understanding which constitutes "learning"' (Rata, 2021, p. 451).

In England, a response to this lack of professional support for TEs has been the publication of the National Professional Qualification in Leading Teacher Development Framework (NPQLTD) (DfE, 2020). Rather than offering a theory of knowledge, this document references a theory of change that helps leaders to deliver programmes with consistency. This consistency is one of alignment rather than coherence. 'Facilitators' are encouraged to 'check whether teachers learn what was intended' (DfE, 2020, p. 11), a focus on training, rather than the development of systematic knowledge concerning what is educationally desirable in our rapidly changing world (Biesta, 2021). In the same way that sustainability and teachers have been positioned reductively in policy and strategy

documents, the epistemic work of TEs is being undermined by manifestations of their work such as those found in the NPQLTD which ‘encourages an image of teaching as a decontextualized series of interventions with narrow objectives, thus marginalising wider educational goods and purposes and de-professionalising teachers work’ (Hordern and Books, 2023, p. 809).

Arguing for a re-professionalisation of the TE role, Knight (2024) suggests that there are four elements to a TE’s credibility, these are: local social capital, valued expertise, the ability to foster pedagogically productive talk through bringing perspectives beyond those evident in the micro-sites of practice together, and their ability to use knowledge transformatively drawing on their experience as both teacher and colleague of academics. Essential to each of these four aspects is the ability of TEs to relate to systematic knowledge. Such knowledge has powers of abstraction that enable knowledge-building by interrupting subjective, individualised and ideological ways of understanding the world as professionals ‘acquire the means to think objectively and, perhaps most significantly, to be critical of the social order in order to improve it’ (Rata *et al.*, 2019, p.164). As such the TE’s insights are informed by epistemic quality (Hudson, 2018) and enable both epistemic access (Morrow, 2009) and epistemic ascent (Winch, 2013). Epistemic quality relates to how well subject knowledge enables both teachers and their pupils to apply their understandings. Epistemic access is concerned with analysing when and how systematic knowledge is acquired. Epistemic ascent relates to enabling coherent progression in understandings which Winch (2013, p. 134) argues is a ‘key element in curriculum design and that failure to get the sequencing right can have adverse pedagogical choices’.

Such ‘adverse pedagogical choices’ can be particularly significant in SCCE when children and young people ‘increasingly question both the relevance and the impact of climate change education’ (Dave and Hoath, 2024, p. 129). It is therefore fundamental that

TEs are part of the resource network that enable teachers to draw on theories of learning and theories of knowledge to inform their pedagogical reasoning and judgments. However, in a recent survey of 870 teachers in England (Greer *et al.*, 2023) less than half had benefitted from specific professional development related to SCCE; of those that had, over 70% described their professional learning as ‘self-taught’. Furthermore, respondents who undertook SCCE-related professional development reported using a wider range of resources than those who had not (Greer *et al.*, 2023, p.20). It is posited that this ‘wider range of resources’ ought to include TEs who can nurture the intellectual elements of teachers’ professionalism - this was a key aspect of our work in relation to curriculum design coherence for sustainability in geography education project. We will now outline the first phase of this endeavour and justify the second.

Using the CDC model to support SCCE

The CDC model, developed by Elizabeth Rata (2019, 2021) in New Zealand is based on the premise that in order to design the curriculum coherently, teachers need to appreciate the epistemic nature of knowledge. As TEs, one of our initial contributions was to access and contextualise research so that the teacher-researchers became better informed of the relationship between the academic discipline of geography and the school subject. For example in relation to SCCE, we would question the sufficiency of an alignment with a curriculum that solely shared atomised propositional knowledge. In order to increase epistemic access, we recognised the need to reference accessible articulations of key terms in order that we could all contribute insights in relation to complex and contested concepts associated with the project. For example, we settled on the Brundtland (1987) definition of sustainability as ‘meeting the needs of the present, without compromising the ability of future generations to meet their own needs’. Climate-change was understood to mean changes to the global climate system driven by anthropogenic rather than non-human activity. In relation to

geography, we were able to draw on the Geographical Association's (2022) curriculum framework and Ofsted's (2021) subject research review, although we were surprised that the term sustainability was absent from concepts listed in both documents. This led to a productive line of enquiry and as TEs we were able to share, rather than interpret, further scholarship. We utilised Maude's (2020) understanding of sustainability as an evaluative rather than a disciplinary concept as 'it is mostly used to evaluate the implications of environmental change or the economic or demographic viability of a place' (Maude, 2020, p. 234). This proved to be very helpful as we grappled with whether or not sustainability was a key disciplinary concept in geography or whether geography as a discipline had a contribution to make to pupils' and society's appreciation of sustainability. We settled on the latter. One participant commented that 'this was an exciting and engaging part of the project as I was actively involved and keen to share my insights as opposed to other professional development projects where you sit and listen'. It was our analysis of such evaluation comments that led us to the second phase of our project, the self-study and the focus of this paper.

Participants, methods and data analysis

Our self-study draws on our diffractive insights collected over a period of four weeks. Each week we (Diane and Emma) engaged in a professional dialogue as part of our embedded case study approach (Yin 2014). Each dialogue was 'a nested case' relating to the main unit of analysis which included the three teachers and two TEs. The reason that we took each dialogue to be a 'case' was to develop 'an in-depth, holistic understanding of a specific phenomena within a specified context' (Sibbald *et al.*, 2021 pp. 291-292) so that we could take an explanatory and exploratory approach rather than a descriptive position. We will now outline our data collection methods and our approach to data analysis.

Without this self-study element we felt that our influence as TEs would not be sufficiently acknowledged in this project, perpetuating an underappreciation of the distinctive nature of TEs' epistemic knowledge. Diffraction offered us a 'way to figure difference differently' (Barad, 2014, p. 170). Rather than seeing ourselves as outside of project, our presence was part of the project, but not in the sense of a social hierarchy between teachers and TEs, but with regards to our epistemic stance. We did not want to conflate or obscure the different epistemic relationships that we brought, but we also did not want to position such knowledge as being superior to that of our co-researchers. Throughout our analysis we were mindful of the criticism that a diffractive methodology can be overly 'research centric and context-dependent' (Fox and Alldred, 2021, p. 6). We were therefore deliberately intentional in 'reading insights through one another for patterns of constructive and deconstructive interference' (Barad, 2012, p.12).

Participants

Three in-service primary teachers working in primary schools in the West Midlands of England and two TEs (the co-authors) participated in this study. Participants were self-selecting, held a particular interest in curriculum design and had benefitted from previous engagement with the CDC model. We recognised that we were both knowledge producers and knowledge consumers in this project and so were ethically responsible for our intra-actions with the materials, each other and the teacher-researchers (Barad, 2007). Prior to data collection, ethics approval was gained on 6th November 2023.

Data collection

Data were collected from two sources: (1) a qualitative survey with the three teachers who participated in the CDC project and (2) diffractive conversations between the two TEs.

Teachers were invited via email to complete a qualitative online survey reflecting on their participation in the curriculum design project. All three agreed, and responses to the

email survey were returned within two weeks. Drawing on our experience of the initial project and the evaluation report (Swift, 2023), the online survey was designed with four open-ended questions and prompts (see Table 1). These qualitative data and our experiences in the project were the stimulus for the subsequent diffractive conversations.

Table 1 Survey questions

Survey questions
Q1: What have been some of the lasting impacts on your curriculum design thinking?
Q2: Sustainability was a key concept in our work. What were your reflections on the work of others? Have you drawn on any of these shared insights subsequently? Have you been able to build on this work?
Q3: Continuing professional development is often done to teachers rather than with teachers. Having been involved in the CDC project, what are your views on this?
Q4: Have you had any opportunities to share your involvement in the project with others? If so, what have you been able to do?

The diffractive conversations between the authors happened on four consecutive Mondays in November 2023. We grouped the dialogues around the themes of sustainability, forms of knowledge, teacher agency and coherence in professional learning. Each conversation lasted approximately an hour and was audio recorded then transcribed using Microsoft Teams in-built software. We member checked the transcriptions for accuracy prior to data analysis (Stahl and King, 2020).

We analysed the teachers' responses for any 'productive connections instead of limiting the analysis to a critical classification exercise' (Ceder, 2015, p. 3). We were ambitious to contribute data that were 'pro-active in making a more positive contribution to enhancing and increasing the epistemic worthiness of the knowledge generated' (Evans, 2023, p. 13). Following each conversation, word clouds were created to visualise the key terms we frequently used and to understand our spoken word through the meta- conceptual language for the profession that we were keen to foreground; Figure 1 shows the word-cloud created following our first dialogue in relation to sustainability.

<https://www.freewordcloudgenerator.com/generatewordcloud>



The teacher survey provided reflections on the project, curriculum design, impact on learners and teacher professional growth. From the responses, four themes were generated:

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unit of work that better connected ‘knowledge that’ with ‘knowledge how to’ and felt that this would help develop pupils’ geographical understanding of sustainability.

3. **Teachers better understood their knowledge base:** They were intrigued to see how the concept of sustainability was similarly and differently applied in each setting, knowing that similarities were associated more with disciplinary and curriculum knowledge and differences with the historical, cultural and spatial context of the school and its pupils.
4. **Expansive professional development is empowering:** Teachers valued sharing their own insights as experts in their own practice; this non-hierarchical collaborative approach to professional work was a ‘refreshing’ approach to professional development that supported authentic workplace learning.

The themes of sustainability, forms of knowledge, teacher agency and the role of TEs were then used as a starting point for our diffractive conversations and sparked lines of flight not previously considered, yet fruitfully pushed us to think deeper about our roles. A diffractive analysis of the findings enabled us to make explicit in our discussion that ‘differentiating is a material act that is not about radical separation, but on the contrary about making connections and commitments’ (Barad, 2007, p. 184). We were able to make connections between the insights of the three teachers and ourselves as TEs and also commit to the differences.

Conceptions of sustainability

In relation to the conceptions of sustainability, the Brundtland (1987) definition had provided a shared starting point, but had not been offered as an end point; this proved to be significant. We thought it important that teachers should not ‘reproduce’ a definition in their planning or demand such alignment from the pupils. By foregrounding a concept rather than atomised fragments of knowledge, the teachers were therefore able to evaluate the success of their teaching and learning sequences with reference to conceptions rather than by simply seeking

the recall of specific decontextualized information. For example, pupils suggested that ‘to help biodiversity, we can buy a dairy alternative like soy or oat milk’. The teacher analysed the pupils’ appreciation of the relationship between the concept of biodiversity and the referent of consumer choice, rather than simply seeking the recall of alternatives to dairy products. This approach enabled the teachers to evaluate the quality of the pupils’ learning in relation to some of the social, ethical and political complexities recognised as being significant in SCCE.

We were mindful that a criticism of the DfE’s strategy for SCCE is that it offers a sterile ‘knowledge rich solution’ (Dunlop and Rushton, 2022, p. 1090). Therefore we focused on discourses concerning the different forms that knowledge could take and the differential impact that these forms have in relation to curriculum design. With regards to sustainability, it was the recognition that this is a societal rather than a disciplinary concept that proved key. Geography as a school subject, draws on disciplinary concepts such as place, scale and location to enrich both the teachers’ and pupils’ engagement with the concept of sustainability. There was recognition that this is a complex and nuanced concept and that recourse to a single definition would be limiting. Equally there was acknowledgment that if we did not seek to proffer an articulation to initiate curriculum discourses, then that would be equally remiss, as we and the teachers would be floundering in an experiential rather than a disciplined space.

Our credibility was generated by our capacity to access a wide research base to consider what makes for a disciplinary concept and what makes for a societal one, and the recognition that in curriculum design we often reach for both while still able to differentiate between them. A significant aspect of the further thinking and research generated in relation to our dialogues related to the impact of the different forms of knowledge that we ‘grappled with’ in curriculum design.

Paying attention to the forms of knowledge for planning and teaching

It was evident that teachers' engagement with the forms that knowledge takes had not been an element in any previous professional learning. One of the teachers commented that 'the most significant aspect of the project had been focussing on the "missing link" between "know that" and "know how"'. Drawing on theories of knowledge proved to be a lynchpin for the project's success. None of the policy or strategy documents that we encountered in SCCE examined the forms and types of knowledge drawn upon in their analysis. As TEs, our ability to 'steer' and 'enable' teachers to access the theory of knowledge which underpinned the CDC framework, rather than just the framework itself was vital. As a consequence, the teachers were able to differentiate between proposition, procedural and experiential knowledge and connect these with disciplinary concepts. They recognised that the form of knowledge had a 'real' impact on the type of learning enabled and we recognised that it was our ability to present knowledge itself as an object of study that gave us credibility within the project. We appreciated that the term 'knowledge' needed to be unpacked and not used generically but rather recognised as an umbrella term, under which sit a range of forms and types, each of which has different educational potential.

Teacher agency and coherent curriculum design

In the project we found ourselves 'creating learning space for teachers' for example, taking time to conceptualise the terms pedagogy and teaching. We understood pedagogy to mean, 'the act of teaching together with its attendant discourse of educational theories, values, evidence and justifications' (Alexander, 2008, p. 47). We therefore made explicit the theoretical underpinnings to the curriculum design work we were engaged in, so that the teachers could critique rather than passively accept the CDC framework. One teacher was confident that 'being part of the research project makes a huge difference in the success of the implementation'. In their evaluations, the teachers shared how, because they had designed the lesson sequences and gained more professional satisfaction even though this work was

effortful. We recognised that our role as TEs was ‘to increase the epistemic agency of teachers’, particularly in SCCE in England where policy documentation is restrictive and reductive. Our credibility in this sense was secured through nurturing scholarly work. We were particularly struck by an insight from one of the teachers stating that ‘this was not a project that provided an answer or a scheme to follow blindly, but was research based and adding our own insights was refreshing’. The teachers’ design work was more disciplined and intentional as we noticed that they paid close attention to the specialising and organising concepts rather than focusing on the activities that they wanted the pupils to engage in.

Conclusion

Our work contributes to a complex ecological research system in education that encourages the development of teacher knowledge and curriculum design capabilities, thus goes against the increasingly dominant orthodoxy of marketplace curriculum solutions. Our findings recognise the important enabling role of TEs in curriculum design, as they support teachers to think deeply about the nature of knowledge and the use of subject concepts for curriculum coherence in SCCE.

We recognise the small-scale and time-limited nature of our study; however, we want to do this in a celebratory rather than an apologetic way. We were mindful that unlike other professions, such as medicine and law, often practitioner voices are absent from cumulative professional knowledge (Gardner and Shulman, 2005). Post-project diffractive conversations captured our developing retrospective understanding not only of the social elements of our work, but also the epistemic aspects – illustrated by the essential difference that TEs bring to curriculum design projects that foreground coherence rather than alignment (Swift, 2023). In a modest way our project helps to amplify the voices of teachers and TEs within the field of educational research such that we, as professionals, are more ‘able to challenge ill-informed non-educationalist research and to explore innovative ways of teaching and learning, to, in

short, reimagine education’ (Tato, 2021, p. 42). This need is particularly urgent in the context of SCCE as ‘research informed and culturally and contextually sensitive teacher professional development is a fundamental priority’ (Rushton *et al.*, 2023, p. 57) in responding to the global challenges that we face and the need to live more sustainable lives.

There is further research needed to: (1) understand the important role of TEs in the professional development of pre-service and in-service teachers; (2) comprehend the implications for the teacher education knowledge base considering the government's focus on teacher training rather than teacher education; and (3) recognise the importance of coherence in curriculum design as a precursor to other curriculum development activities, especially at times of education reform.

Our application of a posthumanist philosophy and a diffractive methodology has enabled us to recognise that if the work of TEs is conflated with that of teachers, then access to wide-ranging scholarship is likely to be reduced. This is to the detriment of the profession’s contribution to society. Such reductions will ultimately limit the contribution that education can bring in relation to society’s responses to climate change and the need to live more sustainably.

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