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Research article

Applying the principles of culturally sustaining pedagogy to a model for justice-oriented school science pedagogy in England: the science capital teaching approach

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Abstract

There is a need to support more equitable engagement with science, technology, engineering and mathematics (STEM) in schools. However, despite decades of special initiatives, mainstream science education still largely reproduces, rather than challenges, enduring social inequalities, particularly in relation to race/ethnicity, gender and social class. Valuable contributions have been made creating more inclusive science curricula, but there is a particular need to support teachers to adopt equitable (critical) pedagogical practice, not least because the values that inform and are enacted through such pedagogy

shape the equitable potential of teaching, learning and interpretation of the curriculum. This article considers a pedagogical approach built on Bourdieusian theory and insights from over six years of participatory research and development work, conducted by university researchers with 43 secondary teachers, 20 primary teachers and 16 teacher educators. The article asks: In what ways does the approach engender justice-oriented teaching and resonate with the tenets of culturally sustaining pedagogy? Analysis identifies common theoretical imperatives of disrupting dominant power relations, foregrounding and valuing the cultural and social assets of learners, supporting the redistribution of cultural and social capital, and embedding professional critical reflection within school science teaching.

Keywords social justice; pedagogy; teachers; Bourdieu; culturally sustaining pedagogy

Introduction: the need for justice-oriented pedagogies in STEM

The relatively low numbers and limited diversity of young people participating in science, technology, engineering and mathematics (STEM) remains a pressing concern for UK educators, employers and policymakers alike. For some, but notably those in government and industry, increasing and widening participation in STEM offers a key way to address the perceived national STEM skills shortage, which is regarded as a threat to UK economic prosperity (for example, Wakeham, 2016). For others, ourselves included, addressing the systems and practices that exclude under-represented communities from STEM and addressing the elitist culture and practice of STEM are important social justice concerns. Despite decades of research and intervention aimed at widening participation, women, working-class and many racially minoritised communities remain acutely under-represented in the physical sciences and engineering disciplines (AAUW, 2010; Smith, 2011). Evidence shows that these trends are not due to a lack of interest or aspiration on the part of the under-represented, but rather reflect dominant practices that alienate, dissuade, prevent and redirect non-dominant young people from STEM trajectories (for example, Carlone and Johnson, 2007; Hanson, 2009). Reforming school science, technology and mathematics education in more equitable ways thus remains an urgent and important task.

Why focus on pedagogy?

In the UK, much of the considerable effort that has been directed at trying to increase and widen STEM participation has arguably been based on deficit assumptions, whereby under-represented communities have been assumed to lack particular knowledge, attitudes or motivation (such as a lack of interest in science or a lack of understanding of the breadth and/or benefits of STEM careers). However, research has shown that the majority of young people aged 10–18 actually find science interesting (for example, DeWitt et al., 2011) and that instead dominant racialised, classed and gendered inequalities and school science practices, relations and forms of representation can alienate and exclude even highly interested young people from science (for example, Archer et al., 2018; Atwater, 2000). Such work highlights the importance of changing school STEM-related curricula and pedagogical practices.

The task of creating more equitable and inclusive curricula has foregrounded the importance of broadening and decolonising (for example, Gandolfi, 2021) the statutory, narrowly focused, knowledge-heavy school science curriculum that prioritises ‘traditional’ (for example, White, middle-class, masculine) representations and forms of science content. For example, Bang and Medin (2010) discuss a community-based curriculum that was co-developed with Indigenous communities in the US, and that integrated Indigenous knowledge systems and epistemologies in ways that made the content more locally relevant, engaging and inclusive (see also justice-oriented curriculum approaches by Brown et al., 2022; Morales-Doyle, 2017). While localised curricula offer an important and productive dimension of justice-oriented STEM education reform, they can be hard to implement at scale, particularly in contexts such as the UK, where there is a requirement to follow a national curriculum. Moreover, as widely recognised, curricula are mediated and delivered via pedagogy – hence the central

importance of supporting the process and practice of teaching in addition to a focus on the content of teaching.

The impact of teacher pedagogy on student engagement and participation in science has been noted across axes of injustice (for example, gender, ethnicity and social class) and learning contexts. For instance, research by Archer et al. (2019) shows how teachers' science classroom practices often celebrate narrow, hegemonic, middle-class masculine performances of science, reproducing gender norms in science classrooms that exclude young women, particularly within the discipline of physics (see also Archer et al., 2020). Such performances include the competitive shouting out of answers, speaking/interjecting for and/or over others, dominating teacher attention and class activities, demeaning the contributions of others, and reducing the possibility for other students to contribute in their own ways. In contrast, research (particularly from the US) has drawn attention to how justice-oriented pedagogies can actively support agency and engagement among young people from minoritised communities (for example, Calabrese Barton and Tan, 2010; Nasir, 2002; Nasir and Hand, 2006; Rahm, 2010; Rosa and Mensah, 2016; Walker, 2006, 2009, 2011).

In the UK, there are limited resources, opportunities and support for educators to understand, develop and practise equity-focused pedagogy within either initial teacher education or as in-service professionals. Indeed, concerns have been expressed that within the current neoliberal climate of education, issues of equity and social justice are marginalised and accorded little resource or value. Within the primary sector, this is compounded further by concerns about the deprioritisation of science in favour of teaching towards high stakes national tests in literacy and numeracy (Rivera Maulucci, 2010), and at secondary level, there are widespread concerns about limited science teacher specialism and acute issues of retention (for example, Martin, 2023) against a backdrop of a narrow, prescribed national curriculum. There is arguably an acute need for approaches that can support social justice-oriented science pedagogy, but particularly those that can be integrated within existing teacher practices without relying on additional curricula or tools.

To help fill this gap, our research group, working in partnership with teachers, developed a justice-oriented science pedagogy – the science capital teaching approach. This reflective approach sought to establish equitable practices that would help to foster students' engagement with science, and that could be implemented at scale. The development of the approach was guided by our understanding of critical sociology and the values of reflective practice. The iterative development of the science-focused approach also drew on the work of justice-oriented scholars working in education more widely. Below, we reflect on the core principles of culturally sustaining pedagogy as a prelude to mapping the overlap between our approach and these perspectives.

Culturally sustaining (responsive, relevant) pedagogy: some core principles

Culturally sustaining (Paris, 2012), responsive and/or relevant pedagogies (for example, Ladson-Billings, 1995, 2014) and educational practices (Paris and Alim, 2014) are justice-oriented ways of teaching and learning that foreground and challenge social injustices and respect, support and engage learners in more inclusive, caring and effective ways. While there are different emphases across and between each, we suggest that there are five main, interconnected common features of such approaches (and the wider field of justice-oriented pedagogy/practice which these sit within), which resonate with the (primary and secondary) science capital teaching approach (P/SCTA). These elements advocate for: (1) the recognition and disruption of dominant power relations and forms of representation within science teaching and learning; (2) the use of culturally relevant and assets-based teaching approaches; (3) the development of trust and care between teachers and learners; (4) the support of students' agency and social action through science teaching and learning; and (5) the practice of teachers working in partnership with researchers to develop richer pedagogy and research and cross theory–practice divides. Reflecting the ever-changing terminology, we refer to these as CS/RP pedagogy and/or justice-oriented pedagogy. These key tenets are briefly discussed in turn.

Recognising and disrupting dominant power relations and forms of representation

CS/RP approaches are fundamentally concerned with challenging dominant, unjust power relations within classrooms and society. Hence, these approaches support teachers to recognise and disrupt intersectional dominant power relations and forms of representation within science teaching and learning. Students from dominant social groups are more likely to have prior experiences, ways of talking, values and ways of knowing that reflect those that are practised and valued in schools (Ladson-Billings, 1995). Hence justice-oriented pedagogical approaches seek to help teachers to accept how dominant educational norms and values may not value or acknowledge all learners' own ways of knowing and being, and, in response, open up ways in which they might recognise a more diverse range of ways of knowing and being as signifying a 'good science student', or as someone who thinks 'scientifically' (for example, Archer et al., 2018; Carlone et al., 2015). As Banks et al. (2007: 28) have argued:

Being born into a racial majority group with high levels of economic and social resources – or into a group that has historically been marginalized with low levels of economic and social resources – results in very different lived experiences that include unequal learning opportunities, challenges, and potential risks for learning and development.

Hence justice-oriented pedagogies seek to recognise and broaden symbolic regimes of representation within the science classroom.

Using culturally relevant and assets-based approaches

A second key tenet is to value and centre the cultures of marginalised students (for example, Ladson-Billings, 1995, 2014; Mensah, 2011) by adopting an assets-based approach to teaching and learning (for example, Jammula and Mensah, 2020). This means recognising and valuing learners' extant knowledge within learning (Hodson and Hodson, 1998; Palincsar, 1998) and drawing on young people's cultural knowledges and experiences – or what has been termed their 'funds of knowledge' (Moll et al., 1992; Rosebery et al., 2005). Moll et al. (1992) explored ways of legitimising the everyday knowledge of Latinx students in US schools and found that, when educators valued and leveraged the rich funds of knowledge held by these learners, deficit perceptions around Latinx students' 'ability' were found to be untrue. Further, differential attainment could be explained as being due to the variable alignment of the learners' everyday knowledge with that expected in traditionally Anglo-American classrooms. Moll et al. (1992) highlighted the value of understanding students in their own settings in order to create classroom learning contexts that acknowledge and share the norms, conventions and structures of those experienced by learners outside the classroom. Wider work has similarly shown that student learning and engagement is enhanced, and students feel empowered, when they are supported to learn in ways that value and respect their interests, knowledge and cultural backgrounds (Nasir and Hand, 2008). In science classrooms, such approaches involve educators making explicit the intellectual resources embedded in learners' daily practices, while science content and meanings that are relevant to students' communities are identified and valued, supporting learners to see themselves and be recognised by others as competent in the domain of science. For instance, in the US, the Transformative Professional Development model (Johnson and Marx, 2009) drew from culturally responsive pedagogy (Ladson-Billings, 1995) and involved researchers working with teachers from urban schools with high numbers of students from under-represented communities. The approach involved whole-school professional development that supported teachers to develop more inclusive and positive classroom environments through caring and inclusive student and teacher relationships (see, for example, Johnson and Elliott, 2020).

Developing trust and care between teachers and learners

Various studies of successful STEM students from minoritised and under-represented communities have drawn attention to the important role played by a pedagogy of care, in which teachers 'teach with love, combining care, commitment, knowledge, responsibility, respect, and trust' (hooks, 2003: n.p.), and attend to issues of positionality and power between teachers and learners. For instance, research has drawn attention to how an ethics of care within pedagogy, but particularly when enacted in culturally

sustaining ways by teachers of colour, supports Black STEM student success, and makes a significant difference to young people's STEM engagement and trajectories (for example, Mensah, 2011; Mensah and Jackson, 2018; Nasir et al., 2019). As Nasir et al. (2019) set out, an ethics of care and love within pedagogy can have a powerful impact on the engagement, learning and progression of young people from under-represented communities.

Supporting students' agency through science teaching and learning

Culturally sustaining pedagogical approaches seek to reposition the goal of science teaching and learning as being to support young people's agency (for example, Calabrese Barton and Tan, 2010; Schenkel and Calabrese Barton, 2020), rather than just support attainment per se. This involves supporting students to incorporate and use their scientific knowledge and skills in ways that are relevant and important to their own lives and their communities, for the social good. For example, Calabrese Barton and Tan (2010) describe how young people were supported to position themselves as community science experts, using their science knowledge and skills to address injustices and challenges for the benefit of their communities. Similarly, Morales-Doyle (2017) documents one teacher's use of a justice-oriented chemistry pedagogy, which not only helped to increase the academic attainment of minoritised students in the class, but also helped these students to see themselves as transformative intellectuals.

Research–practice partnerships

Finally, we note that CS/RP and justice-oriented pedagogies often draw on participatory and research–practice partnership approaches, in which teachers and researchers work collaboratively to cross theory–practice divides (for example, Mattheis et al., 2020). Such approaches embody the disruption of traditional power relations and hierarchies, and aim to enhance both research and teachers' capacity to engage in justice-oriented pedagogy (Fortney et al., 2019; Mattheis et al., 2020). Such approaches are particularly prevalent within pre-service teacher training (for example, Mattheis et al., 2020), but they have also been used in work with in-service teachers (for example, Calabrese Barton et al., 2020). It is important to note that there is a growing attention to issues of social justice in STEM teacher training in US teacher education programmes, yet, in the UK, there is still limited time for and focus on these pedagogies (see Bagley and Beach, 2015).

The science capital teaching approach: theoretical foundations

The conceptual basis of the (primary) science capital teaching approach is grounded in Pierre Bourdieu's sociological framework (for example, Bourdieu, 1977, 1984; Bourdieu and Passeron, 1990). It is integrated with insights from justice-oriented pedagogies and extended through a specific focus on how pedagogy might value, support and build children's science-related forms of cultural and social capital in justice-oriented ways (Archer et al., 2015). In so doing, the approach can be considered to attend to the politics of recognition and redistribution (Fraser and Honneth, 2003) within critical pedagogy. Bourdieu's work is particularly useful for foregrounding the powerful role of social structures, relations and injustices within education, and it has been used to understand why science education pedagogy and practice more often reproduces than challenges inequalities. A Bourdieusian lens helps to make visible the dominant impetus towards the status quo, and, in turn, guided the adoption of four key ideas in the construction of a practical model for use by teachers.

First, a Bourdieusian approach advocates for the recognition and valuing of all students' *habitus* and *capital* within the classroom, but with a particular emphasis on ensuring the inclusion of students whose knowledge, identities and experiences have traditionally been marginalised, undervalued and excluded from science. *Habitus* refers to the socially constructed and embodied framework of dispositions that individuals acquire through processes of socialisation. Thus, a person's science-related experiences over time and across different contexts, shaped by their social location, will cultivate a sense of whether science feels 'for me', or not. In this respect, *habitus* can be understood as similar to notions of identity, in that it refers to a sense of the self (in both individual and collective terms) that is produced through a person's social positioning in relation to axes of power such as gender, 'race'/ethnicity, ability and social class, and, in turn, shapes their engagement with the world. *Capital* refers to the cultural, social,

economic and symbolic resources that an individual might possess. When an individual has particular forms of capital that are valued by the field, this facilitates social advancement, and enables them to 'succeed' within a given field. For instance, economic capital and competence in particular dominantly valued forms of science knowledge and/or skills may support a science trajectory. Hence, our approach involves recognising that dominant practices in science exclude and devalue many young people, and then working to change these conditions and practices (changing what and who is valued, and redistributing capital), so more young people are able to connect with and learn science in inclusive ways.

Second, for Bourdieu, social change and going against the grain of social reproduction require the development of a critically reflective habitus – that is, a habitus that recognises inequalities as social products (rather than, say, as the result of individual merit or talent), and can adopt a reflexive understanding of one's own positionality. Hence critical pedagogy needs to support critical reflexivity among both students and teachers.

Third, a Bourdieusian lens highlights the need for a redistribution of exchange-value capital between learners. Currently, the distribution of exchange-value forms of capital (that is, symbolic, high-status forms of capital that can translate into social mobility and advancement) is uneven across society and biased towards socially privileged communities. Crucially, according to Bourdieu, the value of capital is not fixed, but is determined by the *field*, the space of power relations that sets the 'rules of the game' and determines what forms of habitus and capital are valued, or not, within a given setting (such as a science classroom). Hence, fourth, there is a need to shift regimes of power in the field, such as what and who is valued by the field of science education. For instance, a student's capital in the form of their cultural knowledges may be valued as important in one science classroom, but ignored or marginalised in another.

In these ways, Bourdieusian-inspired approaches to pedagogy aim to interrupt what Bourdieu terms 'pedagogic work', and to challenge dominant regimes of representation within the field of education. Pedagogic work refers to explicit and implicit practices of schooling, as performed by and through teachers, curricula, education policy and so on. Bourdieu's argument focuses particularly on how pedagogic work socialises young people to 'know their place' in the social order, and reproduces dominant group values and culture by inculcating students to accept these values as legitimate and 'just the way things are' (Bourdieu and Passeron, 1977). Pedagogic work produces sustained long-lasting dispositions that endure beyond a student's time at school. For instance, Archer et al. (2020) draw attention to how pedagogic work conducted by teachers within physics classrooms in England led to the reproduction of gender and classed patterns of participation in the subject through the cultivation of particular dominant ideas of what physics entails and who constitutes a legitimate physicist among advanced level physics students, while simultaneously encouraging young women and other students to come to see physics as 'not for me', despite their interest and attainment in the subject. Hence critical pedagogy – such as that promoted by CS/RP, and from a Bourdieusian perspective – seeks to foreground the dominant assumptions and practices that form part of the everyday pedagogic work, and to support teachers to explicitly change their practice in ways that disrupt and challenge these dominant ideas.

We next detail the nature and development of the P/SCTA, and highlight the congruences between the key tenets of CS/RP and the specific elements of the P/SCTA.

The P/SCTA and its development

The P/SCTA was co-developed in a UK research–practice partnership with 43 secondary school teachers and 20 primary school teachers over a period of six years (2015–21). During this time, teachers and researchers worked collaboratively to develop, implement and research the approach. The development process was replete with false starts, epiphanies and concerted partnership work to repeatedly test and refine the approach (see King et al., 2015). The final resulting model – the science capital teaching approach (published as teacher handbooks, see Chowdhuri et al., 2022a; Godec et al., 2017) – combines a Bourdieusian theoretical grounding with the key tenets of justice-oriented pedagogy, discussed above, whereby dominant power regimes are disrupted by changing the field (supporting changes to science teacher pedagogy) in ways that enable the habitus and capital of young people from diverse, under-represented and minoritised communities to be valued and recognised within science teaching and learning to support their agency and social justice.

The name of the approach emerged organically through the research–practice partnership, and it references the science-specific Bourdieusian grounding of the approach in a way that was felt to be accessible. In line with justice-oriented pedagogical principles, the approach is based on cycles of critical professional reflection and intentional action, in which teachers are supported to identify and adjust aspects of their practice in order to challenge (rather than reproduce) inequitable (racist, sexist and capitalist) structures and practices – making small changes to their pedagogy that are aimed at challenging and redressing imbalances in power and privilege. By changing the field of science teaching and learning, teachers attempt to shift everyday transactions of science in schools, in the hope of exposing/challenging often invisible inequitable structures, and supporting and valuing young people’s identities and experiences as valid and legitimate forms of expertise within science teaching and learning.

As detailed in Figures 1 and 2, the P/SCTA model was iterated and developed between the secondary (Figure 1) and primary (Figure 2) phases of the research and development work. The partnership with primary teachers involved unpacking and expanding the foundation of the approach (‘broadening what and who counts’) in response to observations that this important foundation was often ‘missed’ in interpretations and applications of the secondary model. Figure 2 also makes clear that the approach is based on a bedrock of existing good science teaching practice, which has previously been defined as comprising child-centred learning, inquiry and investigation-based teaching and learning, and social constructivist approaches (for example, Hodson and Hodson, 1998; Palincsar, 1998). We now detail the key features within the P/SCTA model, explaining how these combine insights from justice-oriented pedagogy and Bourdieusian theory.

Figure 1. The 2017 model of the science capital teaching approach

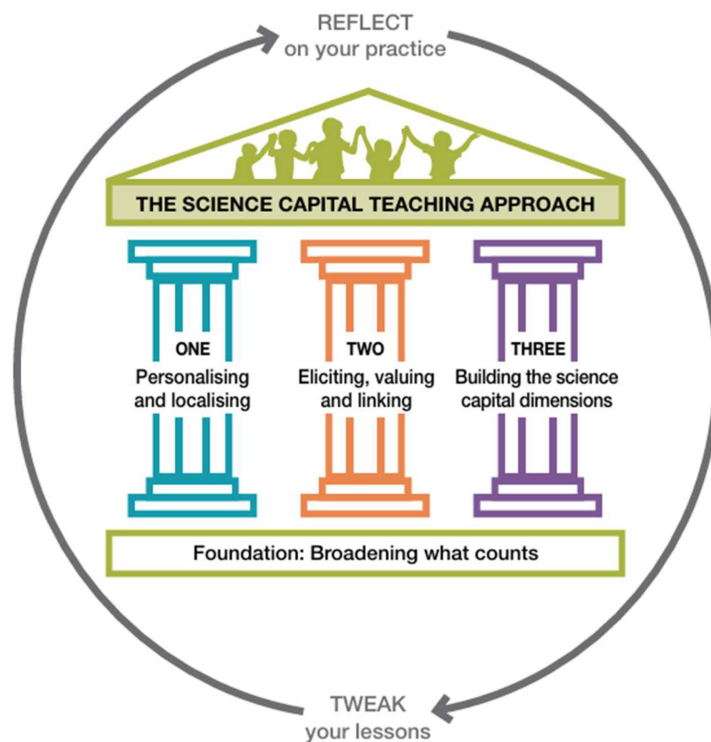
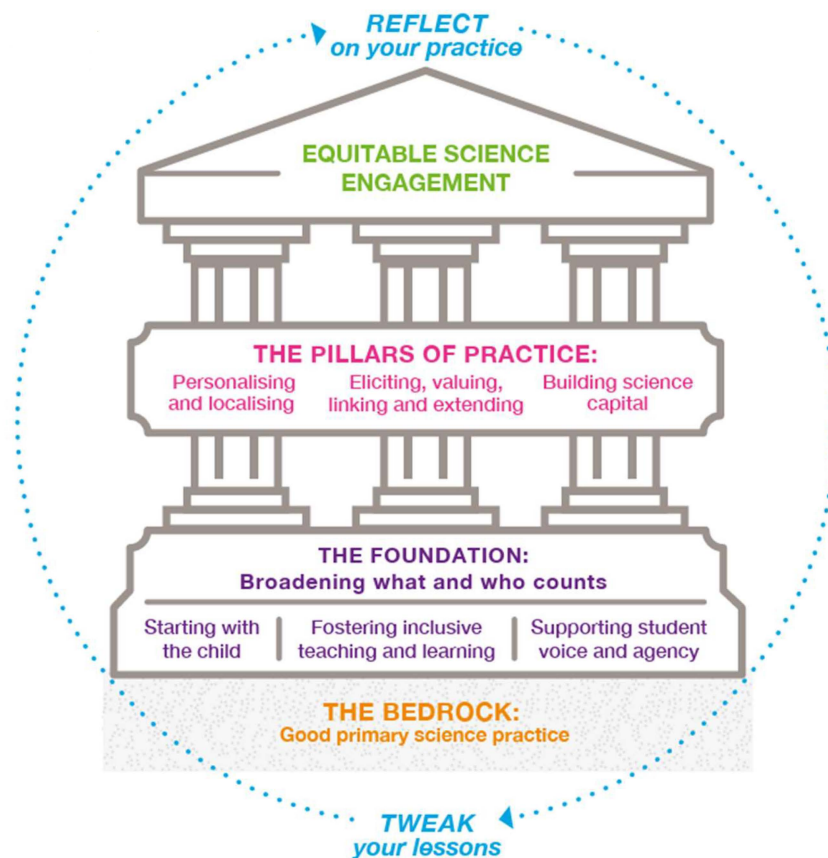


Figure 2. The updated 2021 model of science capital teaching approach



The foundation: broadening what and who counts

The foundation of the approach acknowledges the importance of the wider field with respect to the recognition of a student's capital, and calls for the re/construction of a learning environment that welcomes and legitimises a wider range of experiences, skills and behaviours. It involves creating spaces where all students feel able to offer contributions that are, in turn, valued by educators. As such, the foundation seeks to challenge dominant science norms that are established in classrooms which structurally disadvantage some children. The approach suggests three practical ways of achieving this: starting with the child, fostering inclusive teaching and learning, and supporting student voice and agency.

Starting with the child critically reorients the lens of science learning from the 'science content teaching objectives' to the child. This lens shift supports teachers to start thinking about what the children might know, rather than what they ought to know. As indicated in Table 1, this resonates strongly both with culturally relevant asset-based pedagogies, and with pedagogies of trust and care. Starting with the child involves an active noticing and interest in children's lives in order to orient lessons towards their interests and needs. Studies by Johnson and Elliott (2020) and Brown and Crippen (2016), discussing culturally responsive teaching-oriented professional development, found that such approaches help teachers to learn about children through everyday interactions that are then leveraged in science lessons. This sort of active listening and noticing can also be found in pedagogies of care, recognising the importance of interrelations, trust and care in socially just education (Dimick, 2012).

Fostering inclusive teaching and learning encourages teachers to reflect critically on power dynamics within their classrooms to be able to find pedagogical ways of disrupting them. This element explicitly seeks to disrupt power imbalances that reproduce social inequalities within a caring pedagogy (Table 1). For instance, a teacher might welcome and legitimate a broader range of ways in which children

can contribute to and/or be assessed in lessons, considering the language and forms of representation used, and how these may privilege particular forms of habitus and capital.

Supporting student voice and agency takes the effort of creating an inclusive space a step further to empower science learners beyond knowledge acquisition. Science teaching thus enables access to powerful knowledge, and empowers learners to become critical thinkers, citizens and transformative intellectuals. Hence, teachers use science lessons to support children in building a sense of ownership about what they are learning, and exploring how science learning connects with their local communities. That is, teachers foreground learner agency which supports children's critical understanding of their own and their communities' needs, struggles and injustices (Schenkel and Calabrese Barton, 2020).

Pillars of the P/SCTA

Standing on a strong foundation, the model includes three interrelated pillars of science teaching practice: personalising and localising; meaningful eliciting, valuing, linking and extending; and building science capital dimensions. These pillars direct attention to creating a learning space in which students' experiences and cultural resources are recognised and valued, alongside an emphasis on building students' science-related capital to enable them to 'get on' in science. Learners' engagement, experiences, aspirations and identification with science are shaped by the extent to which that setting recognises, values and legitimates who students are and what they bring with them (Archer et al., 2015). Thus, the pillars call teachers to strengthen students' relationship, identity and agency in relation to science.

Personalising and localising helps teachers to connect the science content to students' own lives, experiences and understandings. Context-based science learning has long been important to science education, yet there is often a lack of emphasis on cultural and political aspects of context (Sevian et al., 2018). Context-based learning continues to focus on the application, comprehension and utility of science in everyday life, whereas this pillar supports teachers to foreground cultural, personal and political aspects of children and schooling.

Meaningful eliciting, valuing, linking and extending takes personalising further by encouraging children to bring their own knowledge and understanding into the classroom. Teachers develop techniques to elicit responses (meaningfully) and then value them. This is an important opportunity for teachers to validate and legitimise different kinds of classroom contributions, and to break the illusion that only certain 'scientific talk' can be included in the classroom.

Building science capital dimensions reflects the Bourdieusian framework and work conducted by Archer et al. (2015) based on the role of science-related forms of capital in shaping young people's science identities, aspirations and trajectories. This dimension helps teachers to consider ways of supporting children's scientific literacy, science-related dispositions/preferences, symbolic knowledge about transferability of science in the labour market, science-related behaviours and practices (consumption of science-related media, participation in out-of-school science-learning contexts), and science-related social capital (knowing someone who works in a science job, parental science qualification, talking to others about science, future science aspirations, science identity). Through this pillar, teachers are encouraged to explicitly disrupt power imbalances and stereotypes related to representations of school and out-of-school science.

How Bourdieu and the P/SCTA relate to CS/RP

Science teaching and learning is shaped by interactions of habitus, capital and field. Classrooms, like wider society, are spaces of power and position-taking that reflect and reproduce inequalities. However, justice-oriented pedagogies aim to disrupt these dominant relations and support more inclusive and agentic representations, practices and ways of being. Both culturally sustaining pedagogies and Bourdieusian-inspired approaches seek to support teachers towards more inclusive practice in ways that focus on changing the field, rather than seeking to change the student.

In Table 1, we draw on the previous summary of key literature to visually map the conceptual congruence between the key elements of the P/SCTA, the core values of CS/RP and Bourdieusian theory.

Table 1. Mapping of key elements of P/SCTA against core values of CS/RP and Bourdieusian theory

		P/SCTA					
		Foundation			Pillars		
		<i>Starting with child</i>	<i>Inclusive teaching and learning</i>	<i>Agency/voice</i>	<i>Personalise and localise</i>	<i>Eliciting, valuing, linking and extending</i>	<i>Science capital dimensions</i>
CS/RP	<i>Disrupt power</i>		x		x		x
	<i>Culturally relevant and assets-based</i>	x				x	
	<i>Agency</i>			x	x		
	<i>Trust/care</i>	x	x	x	x	x	x
Bourdieusian theory	<i>Valuing subordinated habitus and capital</i>	x	x		x	x	
	<i>Supporting a critically reflective habitus</i>			x	x		
	<i>Redistributing exchange-value capital</i>					x	x
	<i>Shifting regimes of power in the field</i>	x	x	x		x	

Our mapping suggests that the P/SCTA is largely congruent with the key tenets of culturally sustaining pedagogy, as an approach that disrupts dominant power relations, foregrounds and values the cultural and social assets of learners, and supports the redistribution of cultural and social capital and the embedding of professional critical reflection within school science teaching. By emphasising additionally that the foundation and pillars of the approach must stand on a firm bedrock of effective science teaching, and through specific attention to building dimensions of science capital among learners, the approach also extends existing work through a science-specific focus.

Main conceptual affordances and limitations

We were motivated to co-develop the P/SCTA following discussions and partnership work with primary and secondary science teachers who expressed a desire for pedagogical practices that did not require additional curricula or resources. We were also aware of the need to create an approach that combined key ideas from the critical literature to create a manageable model that could work across diverse contexts and classrooms. We were further alert to the relatively limited time devoted to social justice theory and pedagogy within mainstream initial teacher education provision in the UK, and the increasingly threatened time and resource for supporting critical professional reflection within an education system characterised by neoliberalism and new managerialism (for example, Bagley and Beach, 2015). Further, we were aware of the importance of developing such an approach through partnership research in primary and secondary classrooms, in order to embed and normalise socially just pedagogical practices in science – recognising that many teachers in our national context have long felt stymied by the need to deliver a content-heavy curriculum. In this way, the P/SCTA, while reflecting the principles of CS/RP, is distinctive in its application as a manageable, disciplinary-specific model that works across diverse science classrooms and contexts. Primary teacher colleagues also conveyed that

they would welcome a science-specific pedagogical approach, given the perceived marginalisation of science within primary school, where the dominant focus is placed on mathematics and literacy (for example, Rivera Maulucci, 2010).

As discussed elsewhere (Archer et al., 2018; Chowdhuri et al., 2022b), research conducted with primary and secondary teachers who had trialled the approach suggest that it was welcomed, found to be relatively easy to understand and implement, and resulted in a range of benefits for both teachers and learners, such as increased student science engagement and understanding and increased student agency – with positive benefits being most noticeably reported by young people from under-represented communities and those in low attainment sets.

Reflecting on the approach, we suggest that there are both conceptual benefits and limitations to a model that is based on multiple theoretical influences. On the one hand, teachers welcomed the simplicity of a single model that combined a range of evidence and insights in a final product that was kept, deliberately, as ‘jargon-free’ as possible, foregrounding (theory-informed) strategies and techniques rather than the conceptual underpinnings themselves. On the other hand, we recognise that an integrated approach may always be considered less rigorous and valid, and necessarily more complex, than an approach based on a single conceptual source.

Conclusions

The values that inform and are enacted through pedagogy shape the equitable potential of teaching, learning and interpretation of the curriculum (for example, Giroux, 2020). Hence, we consider it a valuable exercise to demonstrate the ways in which the conceptual basis of the P/SCTA grounded in Bourdieusian sociological traditions can be mapped across the values of CS/RP as a way to further cement ongoing efforts to advance justice-oriented pedagogy and apply it at scale. That is, we do not claim the P/SCTA as a panacea or universal solution for supporting justice-oriented science teaching. Rather, we offer this mapping and explication of its conceptual basis as a contribution to wider debates and thinking, with the aim of helping add momentum and resources to ongoing initiatives towards more inclusive and equitable teaching and learning in science in ways that value, foreground and help scaffold critical professional reflection and intentional action. In essence, the model offers a framework for teachers seeking to reflect critically on their practice, confront their own assumptions, and engage in practice that attempts to disrupt dominant ways of doing and being in science education. In this respect, we see it as offering a further stepping stone for justice-oriented research and practice, rather than as a final destination.

Declarations and conflicts of interest

Research ethics statement

The authors declare that research ethics approval for this article was provided by UCL Research Ethics Board.

Consent for publication statement

The authors declare that research participants’ informed consent to publication of findings – including photos, videos and any personal or identifiable information – was secured prior to publication.

Conflicts of interest statement

The authors declare no conflicts of interest with this work. All efforts to sufficiently anonymise the author during peer review of this article have been made. The author declares no further conflicts with this article.

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