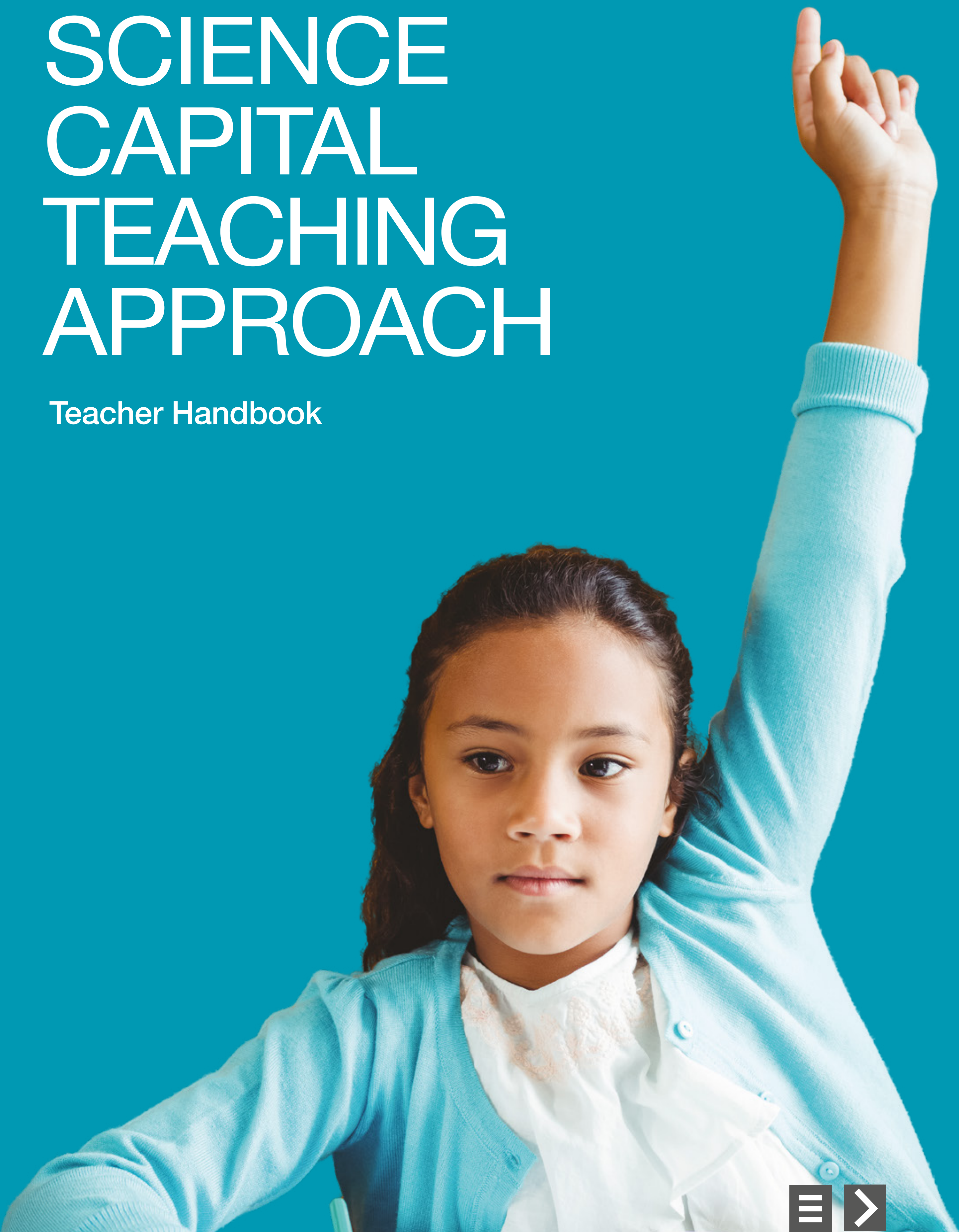
THE PRIMARY SCIENCE CAPITAL TEACHING APPROACH

Teacher Handbook

Primary Science Capital



This handbook builds on action research conducted between 2019-2021 by university researchers working in collaboration with primary school teachers across England. The research team are based at the University College London, Institute of Education and King's College London. The project is funded by the Primary Science Teaching Trust and The Ogden Trust.
All names of schools, teachers and children in the handbook have been anonymised.

Contents

“The approach is not an additional demand but a flow. I have the handbook by my side while I plan my lessons and, if I am stuck or need inspiration, I flick through and find very useful examples that support me in coming up with new ideas.”

(Year 4 teacher, Midlands)

1. Introduction

While science can be interesting and enjoyable, evidence shows that many children experience school science as abstract, disconnected and irrelevant to their lives[1]. As a result, many children see science as something that is 'not for me'. Studies show that these perceptions can start early on in a child's primary school career.

This handbook introduces the Primary Science Capital Teaching Approach (PSCTA) – a teaching framework that helps teachers to reflect on and develop new ways to promote children's engagement and identification with science.

The PSCTA, co-developed by researchers and twenty primary teachers, empowers teachers to make primary science teaching engaging and equitable.

- The approach is built on the bedrock of good primary science teaching practice.
- The foundation of broadening what and who counts in science challenges prevalent representations and ideas of science.
- To strengthen the bedrock and foundation, three pillars provide additional techniques for teachers implementing the approach.

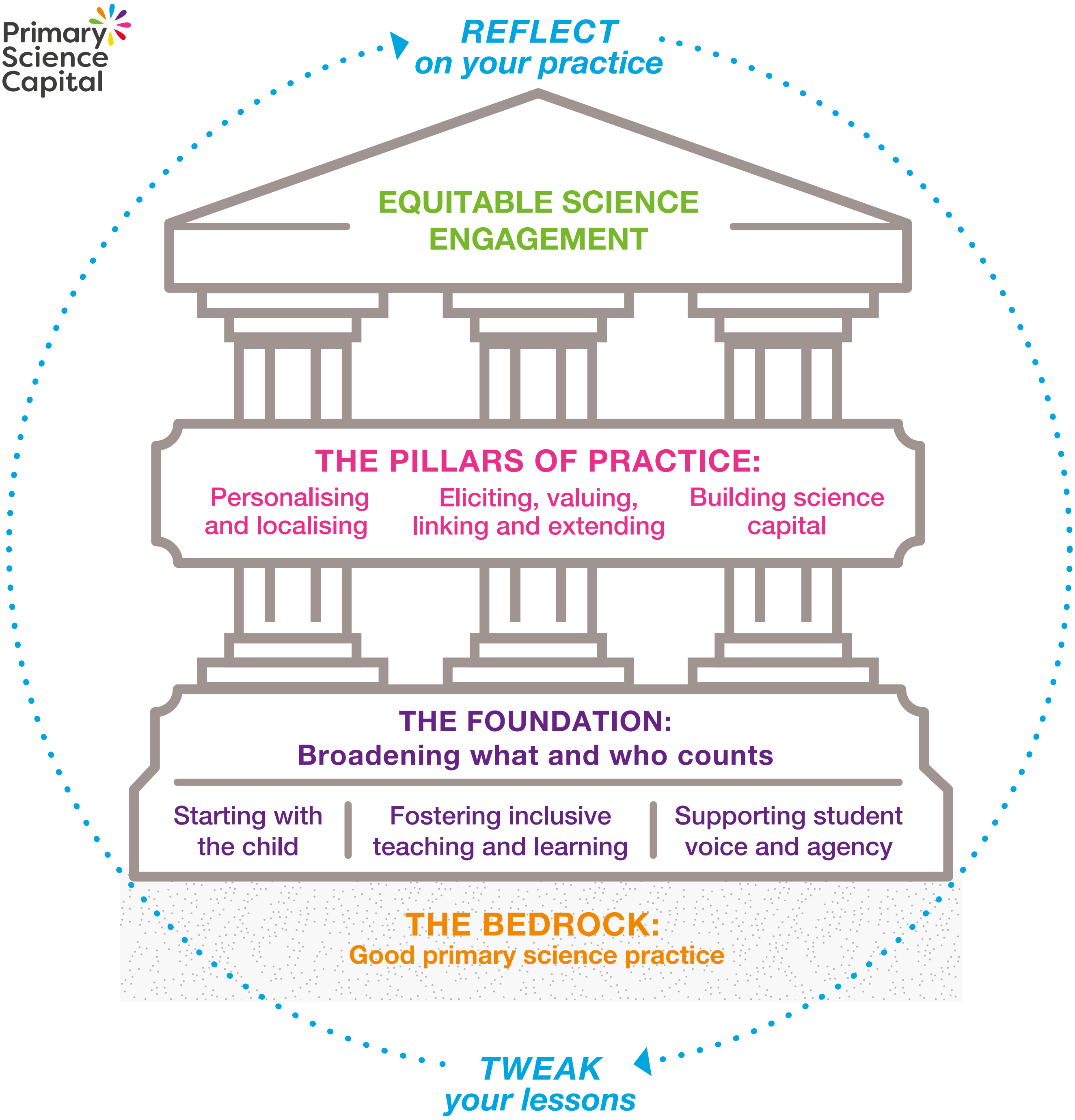
The approach works with any curriculum and involves small tweaks to regular practice. It has been co-developed through a partnership between teachers and researchers. The approach provides guidelines for classroom teaching, and advocates for the importance of a whole-school perspective.

What's in this handbook?


PEER
MEDIATOR

The PSCTA model

The PSCTA – a reflective approach that builds on good primary teaching – has three key foundations, which serve to broaden what and who counts, and three pillars of practice, which strengthen the approach.



“My advice to other teachers:
Don’t ignore this bit of the handbook.
It is hugely important! It makes all
the difference.”

(Year 4 teacher, Midlands)

2. Understanding the ideas

Why do we need primary science to be socially just?

Science education plays a vital role in preparing young people for their future. It can help them to be active citizens and critical consumers and producers of science, enabling them to make informed decisions about their own health and wellbeing, and that of the planet.

Women, working-class people and certain minority ethnic groups are persistently under-represented in the fields of science, technology, engineering and maths (STEM), due to social inequalities within and beyond school science. This lack of diversity limits achievements and developments within the science community, hampers public scientific literacy and can prevent young people from pursuing STEM careers.

Science education in primary school is particularly important. Research has shown that young people's perceptions of science are often formed before the age of 11 and many primary children already think that 'science is not for me'[2]. In this handbook, we show how teachers have used the PSCTA to help change these patterns, helping more children to identify and engage with science.

The PSCTA is based on ideas of equity and social justice – at its heart, the approach is about changing practice to better support children and challenge injustices, rather than trying to change the child.

Example

When science capital goes unrecognised

Malcolm enjoys football. He also likes learning about cars from his father who is a mechanic. He says that he has not met anyone scientific and doesn't feel that science is for him.

Kalifa is keen to learn about science, but very few of the scientists she hears about in school are Black or women.

Samuel doesn't think he is any good at science. The other children in his class would agree. Samuel prefers to work quietly and doesn't like to volunteer answers, though he often knows the correct response.

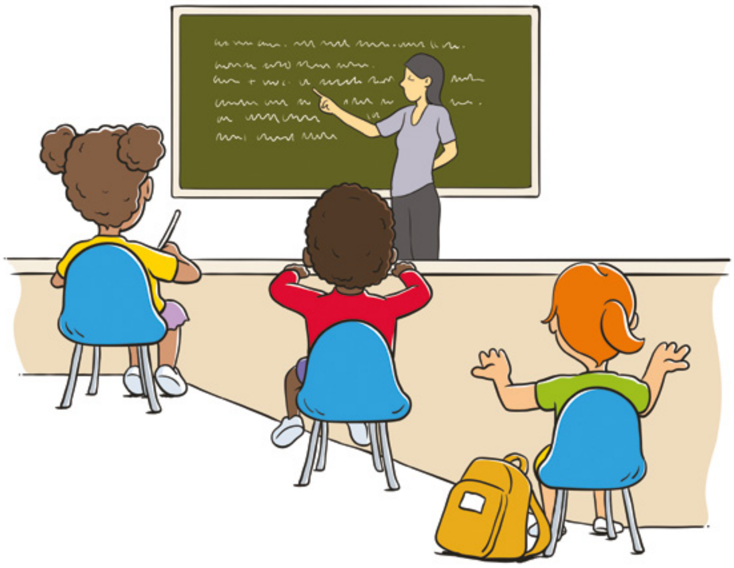
Example 1: Children whose science capital is currently not being recognised

Equality, equity or social justice – what's the difference?

Equality

Equality implies treating everybody equally. But not everybody starts from the same starting point, has the same resources, or experiences the same constraints.

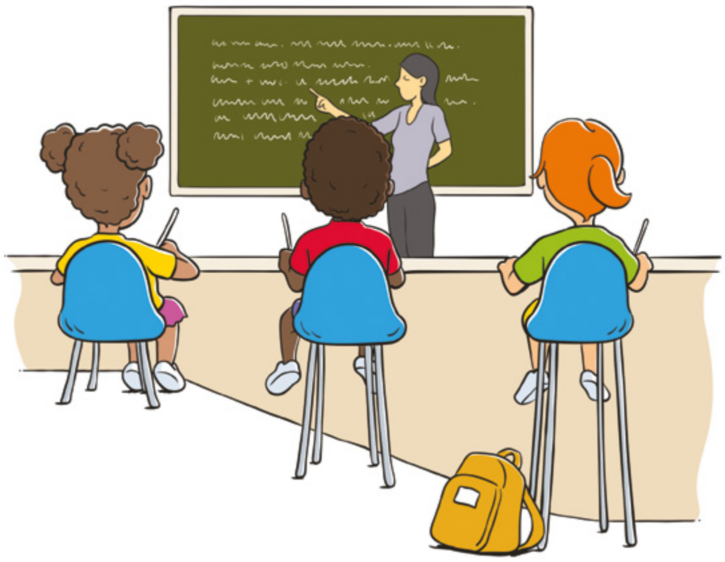
In other words, treating everyone equally can actually exacerbate social inequalities.



Equity

Equity advocates treating people differently, according to need.

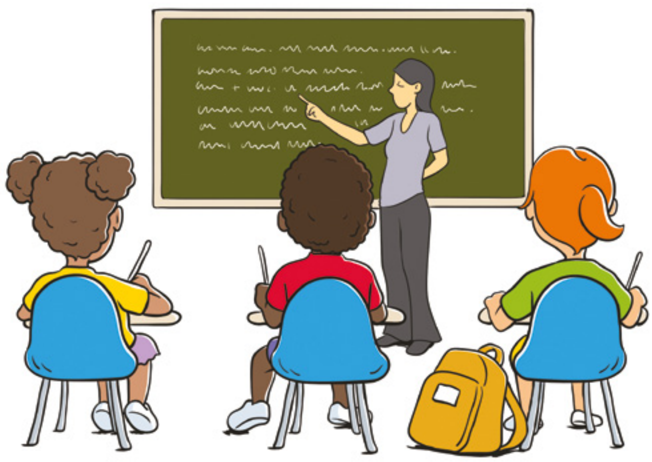
For instance, an equitable approach would mean giving more time and resources to those who need it most.



Social justice

Social justice takes things a step further, and seeks to dismantle and remove systems and processes that create and maintain inequalities.

In this respect, adopting a social justice mindset means teachers foregrounding issues of power and justice within their teaching practice, making their science teaching more inclusive.



"I felt nervous about potentially treating children in my class in different ways, instead of giving them all exactly the same opportunities and experiences. In my mind, inclusion had always been about making sure that no child was left out and it didn't really go further than that.

Slowly, that started to change after I heard about successful lessons taught by the other teachers using this approach. One such lesson involved choosing to focus on a couple of children in the class – the ones that were least engaged and didn't usually feel they had much to contribute. This was such a small tweak, but it made a big difference!

This made me reflect on my own class. There are so many children in my class with parents who give them plenty of rich science experiences. I can see now that those children would often dominate my lessons because they already have knowledge and experience of the topic. In contrast, other children need much more support. My aim now is to work on ways to level the playing field so that all children can share their experiences and be confident to do so."

(Year 3 teacher, Midlands)

To reflect on how your teaching practice uses these ideas of equity and social justice please use the Equity Compass in Appendix A. The Equity Compass is a tool that works in conjunction with the PSCTA to help teachers adopt an equitable and socially just approach to teaching. It also provides a way to record and track progress.

What is science capital?

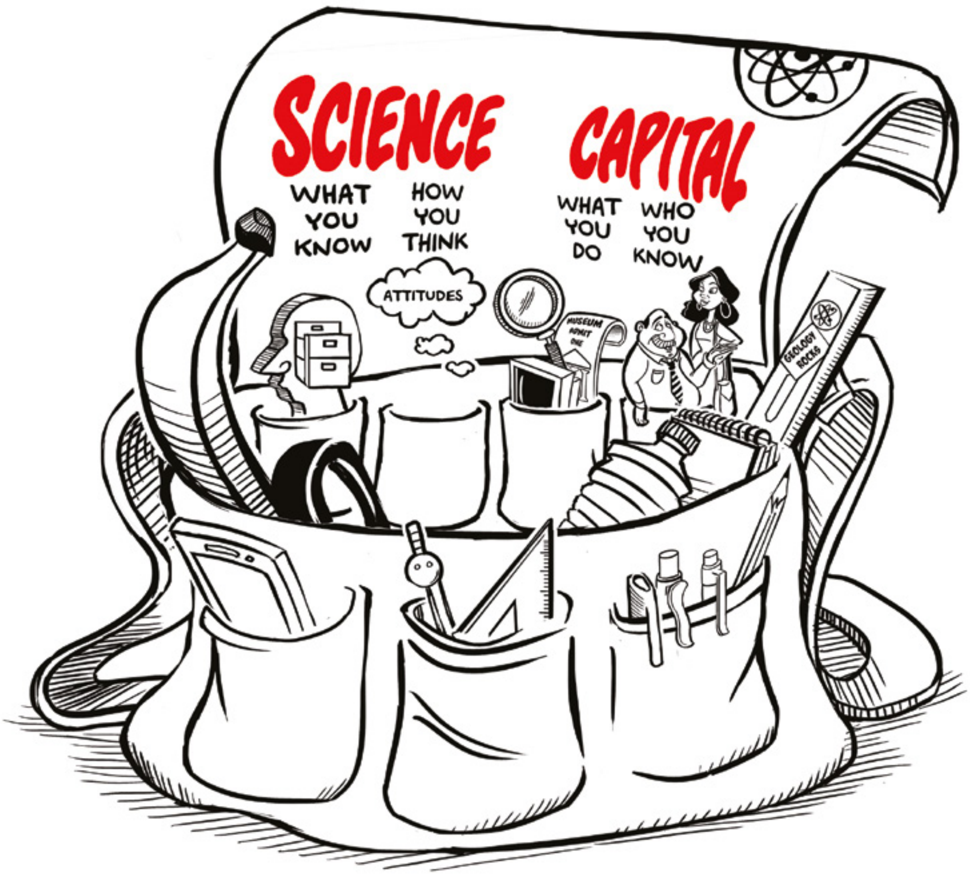
The idea of science capital provides a way to understand and organise all the science-related resources that a person may have. We use a metaphor to help explain this: your science capital 'bag' holds all of your science-related interests, knowledge, relations and behaviours. The contents of this science capital bag can be grouped into four 'pockets', encompassing:

- What you know about science (e.g. your scientific knowledge, literacy and understanding);
- How you think about science (your science-related attitudes and dispositions);
- What science-related activities you do in spare time (e.g. reading about science, visiting science-related places); and
- Who you know (e.g. family members with science qualifications; people who talk with you about science-related topics and significant others who encourage you to engage and/or continue with science).

Science capital is not fixed – its value and potential will depend upon context. As illustrated by Example 1 (see page 9), children may have a range of science-related interests, skills and experiences that can go unnoticed and unrealised within the classroom. School science can also build young people's science capital in different ways. Research has found that the more a child's science capital is developed and valued, the more likely they are (statistically) to identify with science and to see science as being 'for me'[3].

The PSCTA uses this concept to move towards equitable student engagement. The effect of the approach is even greater when adopted across the whole school. Using the approach brings about shifts not only in individual teachers' classroom practices, but also in the wider school culture.

A survey (and instructions for use) for measuring science capital of Key Stage 1 (KS1) and Key Stage 2 (KS2) children can be found in Appendix B. These tools are designed to help track change over a reasonably long period (e.g. a whole or half academic year) and not after individual classes!



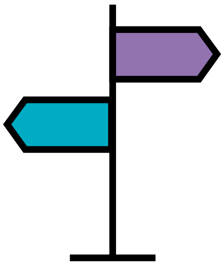
(Image © 2015 Cognitive)

How does the PSCTA help learners?

The PSCTA helps teachers to support children's engagement with science. The approach helps to build:

A science identity – a child's sense of themselves as being 'science-y'. This means being someone who does, and cares about, science, and who is recognised as such by others. By engaging in teaching and learning practices that explore and challenge social inequities, a greater diversity of children can develop a science identity.

Critical science agency – the capacity to use science knowledge, skills and practices to take action on issues that matter to your own life. By gaining greater critical science agency, children and young people can develop and exercise their voices, and actively participate in democratic and civil society.



A science-related trajectory – the ability to see one's future as being science-related, either through participation in formal science (e.g. taking science qualifications and/or aspiring to a science career) or more informally (e.g. engaging with science-related media, out-of-school science clubs or activities).

Helping children to identify and engage with science, and providing them with the confidence and capacity to engage critically with scientific content, will better enable them to take action in their lives. This includes being critical consumers of science stories in the news, making decisions about the physical and mental wellbeing of themselves and others, and caring for the planet.

Example

Dylan's story

Dylan, a Year 3 student, almost never engaged in science lessons. His teacher knew that he was lacking in confidence and felt shy about contributing to the lessons. When the teacher started using the PSCTA, she hoped that this approach would help Dylan to gain confidence in science and encourage him to participate.

The teacher decided to make a particular effort to understand Dylan's needs. She noticed that Dylan often spent his break time watering the plants in the school garden. During a lesson on plants, she decided to ask Dylan about the plants that he particularly liked. Although he was shy at first, he soon began describing flowers that he liked in his grandmother's garden. He also mentioned that he helped his grandmother with watering the plants and weeding. The teacher decided to use Dylan's gardening expertise as the focus for future discussions.

She noticed that other students in her class were surprised and confused by the sudden prominence of Dylan's voice in the class. But they soon appreciated him as someone who had something valuable to share. Dylan's new-found confidence also extended to other lessons. His teacher noticed a considerable change in Dylan's engagement across all topics.

Due to timetabling needs, Dylan was often pulled out of science lessons to attend additional support classes, but he soon started to complain – he didn't want to miss his science lessons!

Example 2: Equity in action – using the PSCTA

3. The PSCTA Model

- The PSCTA is a reflective practice that can be used with any curriculum.
- Teachers use the model to reflect on and adapt their teaching, in line with the core concepts of the PSCTA.

The model is built on a bedrock of good primary science teaching. Its essential foundation is broadening what we value in science teaching and learning in more equitable and participatory ways. The three pillars of the model provide techniques to help support equitable science engagement. The PSCTA engages teachers and schools in cycles of professional reflection, prompting amendments that enhance practice.

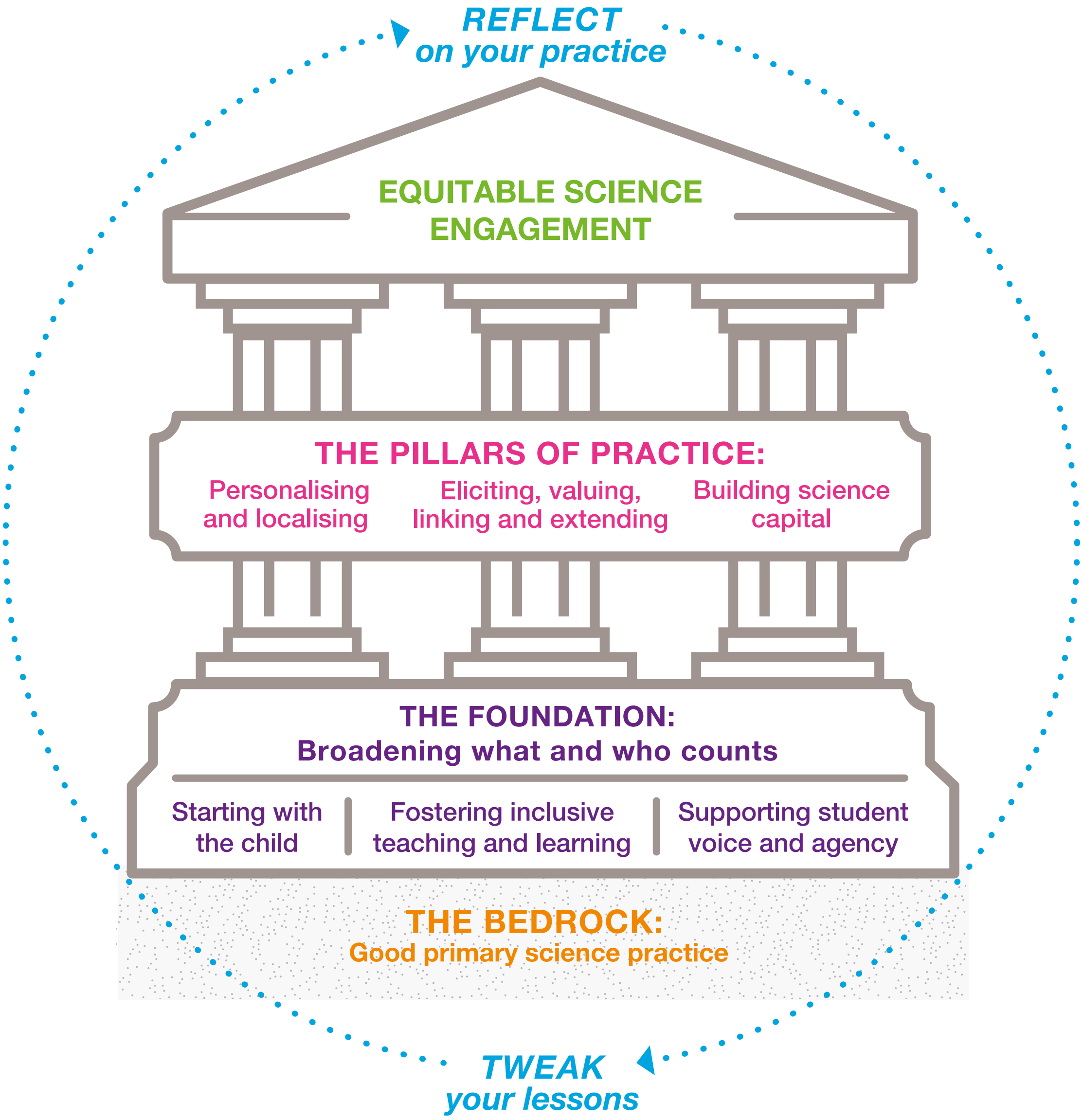
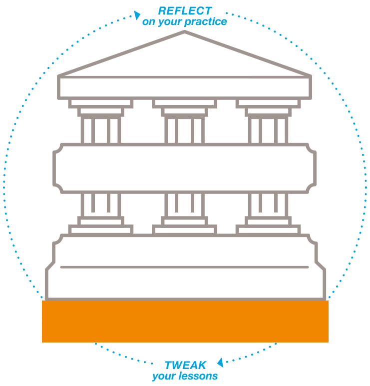


Figure 1: The PSCTA model



Bedrock: Good primary science practice

The PSCTA is built on the bedrock of good primary teaching (including good primary science practice). It builds on the existing extensive evidence base and research literature regarding effective primary teaching practice, which includes teaching through play and the exploration of new ideas and materials, and encouraging students to test their ideas, design experiments and learn from the results.

Online resources

Useful resources and reading materials for teachers, science co-ordinators and governors:

https://pstt.org.uk/resources

www.ogdentrust.com/resources

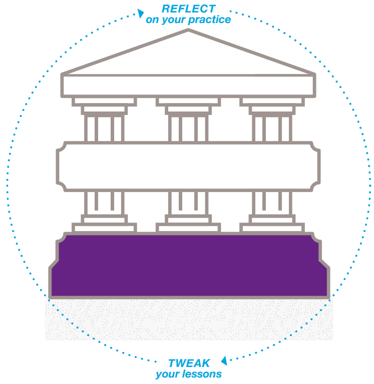
https://www.stem.org.uk/resources/curated-collections/primary-0

https://seerih-innovations.org/science4families/

http://www.psqm.org.uk/psqm-resources

http://www.questionsforgovernors.co.uk/

Essential foundations: Broadening what and who counts



The essential foundation, upon which the PSCTA stands, involves 'broadening what and who counts' in science teaching and learning. This is crucial to ensuring that primary science becomes more equitable and participatory.

Science can be understood and practiced in many different ways. However, school science is often taught from a single, narrow perspective, where what counts as science – and who can be 'science-y' – tends to be narrowly conceived.

We recommend three key ways of broadening what and who counts in science, by:

- starting with the child
- fostering inclusive teaching and learning
- supporting student voice and agency

Starting with the child

The first way to broaden what and who counts in science lessons is to 'start with the child'. This foundational activity reinforces the value of child-centred teaching and learning, and helps bring it to the forefront of your thinking and planning.

Teachers intuitively consider their students' needs, but the pressures of covering content can sometimes hinder child-centred teaching. Focusing on how children experience lesson content, rather than thinking primarily about the content that has to be delivered, can make lessons more meaningful for all involved. Starting with the child also means explicitly recognising the unique contributions that each student can make to a class, and considering how you can value and address this through your teaching.

In order to plan lessons from the perspective of the child, it may be that you will need to learn more about your students' needs and individual interests. This may take time initially, but it is an important investment: building a positive relationship with science early on will help children engage with, attain in, and persist with science as they grow older.

Example

Developing a new strategy: starting with the child

During a whole staff INSET day at a primary school, teachers reflected together on the PSCTA. They felt that their school ethos generally valued child-centric teaching, but when they thought in detail about their particular science lessons, they realised that they typically started both their planning and each lesson with a learning objective, rather than with the child.

The teachers decided that, while each lesson would still have a learning objective, they did not want this to be the lens through which they planned and started lessons. Instead, they decided to plan each lesson by asking ‘how does this topic connect to the children in my class?’. They agreed that students would no longer write out the learning objective as the first task in every lesson. Rather, teachers would begin each topic by exploring links with the identities, lives, interests and experiences of the children in the class.

Example 3: Starting with the child

Example

Snapshot from a science lesson: listening to the student

A Year 4 class teacher decided to include a ‘pre-task’ as an entry point for each new topic, to enable students to make connections between their own experiences and the new topic. For example, before starting the topic on sounds, she set the following pre-task: “During your journey home this afternoon, notice all the different sounds you hear. Write down these sounds and bring them to share with the class tomorrow.”

The teacher began the next lesson with students’ examples and used them to steer the lesson. The children noticed all kinds of different sounds, including car horns, ambulances, people talking in different languages, music playing in cars, birds chirping and dogs barking. The teacher wrote these examples on the whiteboard and asked students if they could think about the similarities and differences between them.

The class came up with creative ideas – some spoke about the volume of the sounds, others described sounds as being nice or unpleasant, and so on. This activity particularly engaged one girl who rarely spoke up. She struggled with learning, and often used noise-cancelling headphones in class when things got too loud. The girl raised her hand and shared her experience of disliking loud sounds, especially when a lot of people talked at once, and explained how traffic noises often caused her discomfort. The teacher had not anticipated the interesting ways in which the lesson developed and was delighted that this particular child had been so engaged and willing to share her experience of sound.

Example 4: Using children’s experiences to start and steer the lesson

> “As an early years teacher, I am so happy to see this approach. I feel that, while the child-led approach is strong in early years, it slowly disappears as the children move to Key Stage 2. I am so proud to be involved in the project and to advocate it, as I feel passionately about continuing to focus on the child during the primary years.”
>
> (Early years teacher, South Coast)

Fostering inclusive teaching and learning

Another key element of broadening what and who counts involves fostering inclusive teaching and learning. A wealth of research shows that teachers and curricula often use examples that reflect the viewpoints, interests, knowledge, experiences, histories and contributions of privileged social groups, such as White, western, middle-class, able-bodied people[4]. This can lead to some children feeling excluded by science. It also means that science teaching and learning is partial and does not reflect or benefit from rich and varied perspectives.

By fostering inclusive teaching and learning, teachers seek to value the many varied experiences and representations that children, and particularly those from diverse backgrounds, bring with them to science. In this way, a child's science journey is grounded within their own life and experiences, rather than being seen as something alien. This is important because ignoring classroom inequalities, and/or treating all children as if they are the same, will only lead to the compounding of inequalities.

Inclusive teaching and learning practice involves providing more resources and support to those children who need it most, recognising that societal inequalities produce different patterns of privilege and disadvantage among students. You can also reflect when planning to ensure that lesson activities do not make particular assumptions (e.g. treating advantaged children's resources and experiences as 'normal') and to ensure that support is provided to enable all young people to participate equally in the activity.

"Jadon finds it difficult to be at school. He's struggling with home life, as he was recently taken into foster care. I found out that he has been given a drum kit by his foster parents, so when we had our lesson on sound I decided to base the lesson around drums.

We did a sound experiment outside, where he played a drum and children moved away to see how sound gets quieter with distance. I also showed different types of drums and asked Jadon – being the 'expert' in drums – to explain how they might all sound.

He was so engaged! He really enjoyed being at the centre of the lesson and being perceived as an expert. I don't think that, before I started this approach, I would have thought about including Jadon's drums in my lessons – but this has made such a difference to both him and the whole class!"

(Primary teacher)

Cultivating inclusive practices involves thinking sensitively about the experiences that you will ask children to share in class, and about resources that may be needed to enable all students to participate in these activities. For instance, do all children have access to printers, paper and craft materials at home? If not, how can this inequality be addressed? Framing a lesson around a daily experience (see Example 4, which explores the sounds that children hear on their journey to school), a shared class experience (e.g. a school sports day or visit) or a local context (e.g. a shop or park near to the school) can help ensure that students can participate in learning on a more equitable basis.

You may also find it helpful to plan a lesson by considering it specifically from the point of view of a child in the class who is from a historically excluded or under-represented community, and/or a child who does not often actively participate in class (see Example 2). 'Lensing' the lesson from the viewpoint of these children can help to reveal the complex and subtle ways in which the lesson could be framed more inclusively. This can help identify concrete ways to make learning more inclusive and representative, and to ensure that it acknowledges and values different children and communities.

Have a go

An exercise for increasing engagement

Focus on a child (or children) who are from communities that have historically been excluded or under-represented and/or who regularly seem not to be engaged by science. Think about the following questions:

- How can I ensure that this topic is relatable to this child? How and why might this topic resonate with, and matter to, them?
- How might I relate the topic to the child's prior experience, or cultural context?
- What types of activity (a practical task, drawing, drama, singing, etc.) might provide a chance for the child to showcase their skills and knowledge?
- How can my lesson value this child's interests, abilities, understanding and knowledge, focusing on what they have, rather than what they don't have?

Exercise 1: Techniques for fostering inclusive teaching and learning

Example

Snapshot from a science lesson: taking steps to be more inclusive

The teacher of a Year 4 lesson on materials decided to explore how different shoes (made of different materials) can be used for different purposes. She felt that this example might link with many children's lives and interests, but was also acutely aware that there were students in her class who could not afford many or specialist (e.g. ballet, sports) shoes. She realised that a child who might not own a variety of shoes might feel alienated during the lesson if the others described owning many different and expensive shoes.

Instead of focusing the discussion on the shoes that children owned, she decided to focus on the purpose of different types of shoes that students might know about. Children shared their knowledge of activities, experiences and spaces from their own lives, and then considered what sorts of shoes might be needed (e.g. sports, dance, gardening, school, hot weather, wet weather, indoors). Instead of highlighting what types of shoes children may or may not own, the discussion focused on the different activities that shoes can be used for (while remaining personalised). For example, one child described how their grandmother knitted woollen booties for their newborn sibling, as the baby didn't need sturdy shoes for walking yet!

Example 5: Fostering inclusive teaching and learning by focusing on students' experiences

"During the lockdown – when children were doing home schooling – I got a unique chance to listen to students and encourage ownership of their science learning. During a lesson on light sources, the students started talking about the different lights in their own homes. I encouraged them to make videos showcasing the source of these lights.

One video was particularly intriguing – a student used pieces of coloured cloth to cover their room lamp, which in turn changed the room lighting colours! I decided to share this video with all the children, and they were very excited by this. One of the students suggested that they use these techniques during theatre performances – an idea that was met with excitement. I asked the students to send me videos of them doing lighting effects as they performed (theatre pieces, songs, poems, skits etc). The children were used to making social media videos, which they enjoyed watching and filming, so they loved this challenge!

The students then decided that, once they were back to face-to-face teaching, they would stage a small play together using all the different lighting techniques!"

(Year 3 teacher, Midlands)

Supporting student voice and agency

The third key element of broadening what and who counts takes the approach a step further by encouraging students to have a voice in the way lessons are designed and taught. Besides listening to children, this practice enables teachers to support students in making active decisions about their learning.

Student agency also refers to when children are able to use their knowledge and learning to take informed action in their lives. Science learning then moves beyond the classroom and impacts their lives. Student voice and agency helps them to participate as active and democratic learners, and to take ownership of their learning.

Example

Encouraging students to lead: directing decisions using the student voice

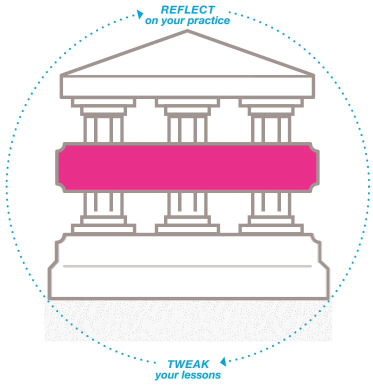
A Year 5 teacher was aware that no matter how much she tried to involve students in her teaching, she always tended to make all the decisions around how and what to teach. She wanted to change this. At the beginning of the year, she turned the science bulletin board into a space – called *My life, my science* – for students to share any science story from their lives. Students were free to submit stories, poems, photos or models from their lives that involved participating in ‘science’. Students could do this as individuals or as a group. She also gave them time every two weeks to engage with each other’s work on the board.

The teacher was initially concerned that students might draw incorrect scientific conclusions or include irrelevant content. In the first term, children asked her lots of questions: “What kind of story should I write?”; “Can I write about what my mum cooked yesterday?”; “Can I talk about my dog?” She encouraged them to write whatever they wanted, as long as they linked it to a ‘science topic’. Slowly, the board started to fill up and she could see that the science stories were becoming more and more creative. A favourite story came from Carla, who had taken photos comparing her dog’s teeth with her own. Students naturally started to talk with each other about their stories and some of the stories received a lot of attention.

The teacher asked the students what they would like to do with all the stories that they had collected. Many suggestions were made and it was decided collectively that the top three stories (as voted by the students) would be presented during a school assembly. Students also chose some stories that they wanted to explore more together in their class. For example, since children enjoyed the science story about Carla’s dog’s teeth, they wanted to explore this more. Many questions came up: Do they have pets? What sort of teeth do they have? What about birds? This led to more discussion about animals and their habitats – all thanks to the story of Carla’s dog!

Example 6: Promoting the voice and agency of the child

The three supporting pillars



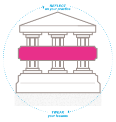
The three supporting pillars of the PSCTA are built upon the foundation of broadening what and who counts and the bedrock of good primary science practice. The three pillars provide techniques for teachers to enact the approach: personalising and localising; eliciting, valuing, linking and extending; and building science capital.

Personalising and localising

Personalising and localising is about making science relevant to the everyday lives of the children in your class. This approach goes beyond contextualising science – the key is to help children to find personal relevance and meaning in science.

The personalising and localising pillar focuses on connecting children with science, so they can see how it might relate to their own interests, identities, attitudes and experiences, both as individuals and as community members. It helps teachers and students to recognise that children have experiences, ideas and wider knowledge that are valued and valuable in science, which in turn supports equitable engagement.

> "A Year 4 child in my class has always been disengaged – refusing to take part in lessons. Rather than treating this as a behaviour management issue, I had some exploratory conversations with him and tried to understand more about his interests and life. I soon found out that his uncle had diabetes and he knew a lot about the dietary restrictions that his uncle had to follow. I rethought the upcoming lesson on the digestive system in humans and said that I'd like to draw on his expertise to help teach the lesson. This child came running excitedly into my classroom the next Monday, bringing with him a wealth of knowledge."
>
> (Science leader, London)



Take a closer look

Contextualising vs personalising and localising

Contextualising - The importance of illustrating a science topic through real-life examples has become widely accepted in science teaching.

For example, to explain the idea of magnets, the teacher shows a video on YouTube of a magnetic levitation train in China. This observed activity exemplifies contextualisation.

Personalising and localising - Taking the notion of contextualising a step further, personalising and localising focuses on real-life examples that are personal and local to the child.

For example, the teacher asks students when and how they have used magnets in their lives. Children offer examples of magnets they have experienced, such as fridge magnets and magnetic beads used to make jewellery and accessories.

Closer look: How personalising and localising differs from contextualising

Example

Snapshot from a science lesson: personalised hands-on activity

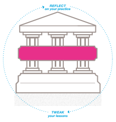
A Year 3 teacher decided that for his next lesson on fermentation he would discuss breadmaking. He knew that bread was something that all children would be familiar with, as the school neighbourhood had many local bakeries. The teacher brought into the classroom different breads from the local bakeries and supermarket. He felt confident that the children would recognise the supermarket and local brands, and would be willing to participate in the discussion.

The children were then asked to choose any bread of their liking from the different ones he provided. They then talked about the springy structure of the bread as a way of turning the lesson to the role of yeast. Using a nearby supermarket localised the discussion and children talked about where their parents went to shop. Children also offered examples of TV programmes such as *Great British Bake Off*, where they had seen the baking process in action. Allowing the children to choose and taste the bread further personalised the lesson. Discussing bread in general was a more local and personal starting point than beginning the lesson by explaining the chemical process of fermentation.

Example 7: Personalising and localising in action

"The approach has made me more aware of the barriers that might arise in science lessons, and of strategies for removing them. For example, if a task requires that children talk to their parents, but I know some parents may not be available, I encourage students to talk to other teachers in the school about the science topics."

(Year 2 teacher, Midlands)



Eliciting, Valuing, Linking and Extending

Teachers commonly ask children questions to ascertain their prior subject knowledge and understanding. However, this pillar focuses explicitly on helping teachers to elicit and value children's personal, family and cultural knowledge and experiences before linking these to the science curriculum.

Eliciting refers to bringing out children's personal, family and/or cultural experiences and knowledge within learning. Eliciting must be meaningful and must recognise students' lives and identities without being stereotypical or tokenistic.

Valuing means explicitly recognising and acknowledging how these experiences and knowledge are relevant and enriching for everyone's learning.

Linking is connecting students' contributions and experiences to appropriate aspects of the science curriculum.

Extending is finding avenues beyond the lesson – within the school, community or across different lessons – to build children's contributions into wider teaching and learning.

Eliciting, valuing, linking and extending reinforces the sense that students' ideas and experiences are valid in the context of science. It helps them to feel more capable of contributing and participating in a given science topic, and it enriches everyone's science learning. In this way, more children feel that science can be for them and the practices of science are broadened and made more inclusive.

"One big change I have seen in the children is that they have also altered their own expectations of science lessons. When I first started the approach, they didn't always volunteer their own thinking or questions so easily. Once they realised that this is how science lessons would be, their questions and input became more and more interesting!"

(Assistant head teacher and science lead, North East)

Have a go

An exercise to help overcome obstacles to eliciting

A Year 2 teacher asked the class, “We’re learning about woodland habitats today – who’s been to the woods?” The students were silent and looked at each other. No one put up their hand. The teacher asked again, adding prompts (e.g. “Maybe you’ve been for a walk in the woods with your family at the weekend? Or you’ve been to a National Trust place, like a big house with woods in the grounds? Or maybe you’ve been out to a forest on a day trip?”) But no one responded. If you were the teacher, what would you do? Here are some useful tips:

- Find out about habitats and places that the children have experienced. Encourage those children to share their experiences, and discuss what the similarities and differences might be with woodland habitats.
- Try to identify examples that value and draw on children’s existing experiences. For instance, are there any stories that the children know that talk about forests or woods? How are these described in the stories?
- Show a video clip of a woodland habitat, encourage the children to say what they can see and hear, and ask them to imagine what it might feel and smell like.
- Identify any wooded areas near the school. Show some images or even a short video that you have taken there. If there is scope, perhaps arrange a short class walk to visit the woods.

Exercise 2: Techniques for addressing challenges with eliciting, especially among younger children

Have a go

An exercise for extending beyond the classroom

Where possible, you can also try to extend the valuing and linking of children’s interests and experiences in relation to science topics. Here are some starter ideas that you can adapt and build on:

- Children could develop their own ‘science and me’ logs, where they can write/draw/paste photos of science topics and annotate these with pictures or words to show connections with their own lives, experiences and interests. This could become a resource for teachers to support planning and learn about students’ lives.
- Encourage children to talk with people at home about their connections with the topic and to share their findings with the class.
- Seek direct feedback and input from parents – whether in person or via online platforms.

Exercise 3: Techniques to extend valuing and linking beyond the classroom

Example

Snapshot from a science lesson: personalising the learning experience

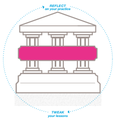
While teaching the classification of animals, a Year 6 teacher wanted to introduce the scientific idea of classification and its applications. While preparing for the lesson, they found an example of how confectionary can be used to illustrate the concept with classifications such as 'chocolates/candies' and sub-classifications such as 'dark/caramel/nuts' and 'jelly/boiled/lollipops'. The teacher felt that this was a good contextual example for the class. Reflecting on the PSCTA, they decided to personalise the example further by eliciting and valuing the children's favourite sweets, as well as sweets that their families like to eat and cook at home. Year 6 included children from various different cultural backgrounds and the teacher felt that this would be an opportunity to value and celebrate their cultural experiences and knowledge of many different types of confectionary.

The teacher started the class discussion on classification by asking about (i.e. eliciting) local Indian sweet shops and asked what the children knew about the different sweets sold there. Students then shared examples of their favourite sweets cooked or eaten within their families and communities. Many children immediately raised their hands and started calling out different types of confectionary, such as *rasmallai, papanasi* and *kheer*. The teacher focused on Gulizar, who named her favourite sweet as *halva*. Gulizar shared her knowledge and love of halva. In this way, the teacher meaningfully elicited and valued Gulizar's contribution by giving recognition and importance to what she was saying and sharing. The teacher then linked Gulizar's contribution to the topic of classification and asked if she knew of any different types of *halvas*. Gulizar identified many types (e.g. red/white, sticky/hard) and revealed that her favourite was the red one. The teacher drew up a classification chart on the board using Gulizar's example and categories. As the lesson proceeded to cover the classification of animals, the teacher constantly referred back to Gulizar's example to help the children understand the topic.

Example 8: Meaningfully eliciting, valuing, and linking students' contributions

"This approach has really got me thinking about differentiation at a much deeper level. It has taught me to look beyond 'sentence starters' and 'question banks', and to see differentiation as a means of understanding and focusing on personalised experiences."

(Year 6 teacher, London)



Building science capital

To help support children's engagement with science, teachers can build their students' science capital by embedding the four areas of science capital across and throughout their lessons. The table below details the four main components of science capital.

Types of science capital	Ideas to build science capital
What you know	• Help children to understand science concepts, ideas and how science works. • Value and build on children's experiential, everyday knowledge.
Who you know	• Help children to recognise the broad range of scientific skills and knowledge that already exists in their families, local communities and school. • Explicitly recognise and value all children's science expertise and encourage them to think of themselves and each other as 'science-y'. • Connect children with people who use science in their jobs, ideally through repeated interactions (virtually or in person) with relatable people.
How you think	• Develop children's science-related attitudes and dispositions through everyday teaching to help them see science as everywhere and relevant to their own lives and future. Help cultivate the idea that science qualifications are transferable and useful for many areas of life – not just for becoming a scientist, science teacher or doctor! • Expand on the idea that a diverse range of people use science skills and applications in everyday life in a range of ways. Everyone has science knowledge and expertise, not just scientists. • Discuss and help expand the role that young people can play in using their science knowledge and skills in their own lives, and to help their families, communities and wider society.
What you do	• Use homework and project work to encourage children to engage in science-related activities outside school. • Introduce students regularly to relevant and appropriate science-related media (e.g. TV, online resources, books, magazines, etc). • Enable children to take part in local (and free, if possible) science learning opportunities • Invite students to share their making, tinkering, repairing, crafting or artistic activities and interests. Value and link their home expertise, interests, knowledge and experiences with lesson content, where applicable.

"I always liked to start each science lesson with a recap activity called 'What I've learnt', which I felt helped to support continuity across lessons. I decided to change the focus of the recap activity from focusing on science content knowledge to building science capital. I explained to the children that their starter activity is now a little different. The class now has to consider: When did I last use a science skill? When did I see science on TV/internet? When did I last use science in my home? When did I see science in the news?

At the end of the lesson, I also actively encourage students to think about questions like: What, from this lesson, are you going to share with the people at home? This new version of the recap activity ensures that the child and their personalised experiences of the topic become the focal point."

(Year 6 teacher, South Coast)

Example

Using local knowledge to build science capital

To help build children's science capital, a science lead created careers flipcharts for every class. He made a particular effort to move the notion of science careers away from elite professions such as medicine and engineering. For example, the chart includes the profile of the local pharmacist – a Black woman who describes the science knowledge that she needs for her job. After one child talked about his mother's interest in plants, the lead also included a picture of the mum and her plants on their balcony, giving the photograph the title 'local botanist'. In so doing, the lead positioned local people known to the class as experts in aspects of science.

Example 9: Building science capital

Valuing interconnections within the approach

The PSCTA has the greatest impact when it is incorporated into everyday teaching practice and sustained over time.

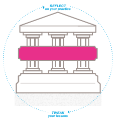
The power of the approach comes from it being an interconnected, multi-component model. Consequently, its impact may be considerably lessened if a teacher chooses to focus on just one component of the model, rather than implementing all aspects of it into their everyday practice.

For example, while it can be valuable to host STEM visitors, or to organise a school trip to a STEM-related experience, it is even better if children are exposed daily to the principles of the PSCTA, through lessons that begin with the child; where science content is personalised and localised; children's experiences are regularly acknowledged, valued and built upon; and their voices and agency are supported and celebrated.

"There was one child in my class who never seemed to engage in my science lessons. I talked with my buddy teacher and tried various different components of the approach, but nothing seemed to be working. I even said to my buddy teacher, 'I don't think we're going anywhere with this. I keep trying to use different things or get him engaged about his life and it just isn't working.'

And then, all of a sudden, in one lesson he was really engaged with it. I think what worked was a culmination of many factors – first, sustained effort, and second, the fact that all the components of the science capital approach were coming together. I now feel confident that, while this might take some time, it does make a difference!"

(Year 2 teacher, South West)



Example

Exploring interconnections within all elements of the PSCTA

A Year 4 teacher recognised that a few of the children in her class appeared to be interested in continuing with science in the future, but most knew very little about careers related to science.

She was intrigued by the PSCTA pillar concerning building science capital and felt it could be useful for helping her to raise the children's science aspirations. In particular, she wanted to expand children's understanding of where science can lead and of who they know in science careers. She decided to invite a scientist to visit her class as a part of a science careers exposure experience. She invited a White, male-identifiying nuclear physicist to come to the school and share his experiences of studying science through school and university, and then pursuing a science career. The children were fascinated by the nuclear physicist, asking many questions about his life and work. Satisfied with the success of the visit, she planned a visit for each term. She felt that this was a good example of using the PSCTA.

So, why should the teacher extend her practice further?

While visits by external speakers, and special events, can form a valuable part of the PSCTA, this alone does not represent successful implementation of the approach. For instance, while the children enjoyed the visit, had now met a professional scientist and better understood what a nuclear physicist does, it did not lead to any of the children identifying more with science, nor did it change their views of school science.

The teacher's colleague suggested that the value of the visits might be complemented and amplified by reflection on all the other elements in the model. For example, how does her teaching approach ensure that all children's contributions are valued? Has she reflected on whether the practice is broad enough to accommodate the experiences and varied types of knowledge of all the children? This reflection is central to identifying who might be an appropriate visitor. Might the class hold negative stereotypes that could be addressed through the visit? Would the class benefit from having, say, a scientist visitor who was a Black woman? Instead of a professional scientist, how about inviting someone who uses scientific knowledge in their job? Will that help to expand what children view as science? Without reflection on all the other elements and identifying the needs of the particular children, a focus on one element cannot produce a successful implementation of the PSCTA.

Example 10: The importance of addressing every component of the PSCTA

“It’s been the best professional development I’ve done. In ten years of teaching, I think it’s the only thing that has really, really made me evaluate my practice.”

(Year 6 teacher, South Coast)

4. The impact of the PSCTA

Over two years (2019-2021), researchers from University College London (UCL) and King's College London (KCL) worked with participating teachers to collect data that would help them to understand the impact of the PSCTA on students and teachers.

Data was collected via teacher interviews, teacher surveys, student surveys and classroom observations. This work was mainly undertaken between autumn 2020 and summer 2021, during which time schools experienced extraordinary challenges and practiced remote learning due to the global COVID-19 pandemic. As a result, teachers' capacity to implement the approach and opportunities to collect data were considerably restricted. Despite the relatively small numbers of children, teachers and schools involved, qualitative and quantitative evidence was found that indicated meaningful changes and positive benefits of the PSCTA for children and teachers – even in these unprecedented and very difficult circumstances.

The impact on students

23%	**increase** in children **agreeing** with the statement 'My teacher links science with my life'.
18%	**increase** in children reporting that they 'Tell someone at home about what I have learnt in science' at least once a month.
14%	**increase** in children **agreeing** with the statement 'Knowing a lot about science can help you to get a job when you are grown up'.
15%	**decrease** in children reporting that they **disagree** with the statement 'When I grow up, I want to become a scientist'.

All the participating teachers' classes had different starting points – some recorded high initial baseline scores while others were considerably lower. Higher baseline scores were found among the teachers who had already been participating in the initial project development phase – these teachers were implementing the approach prior to the start of formal data collection in the second year of the project. The classes of teachers, known as buddy teachers, who joined in the second year of the project and were mentored by teachers with longer engagement generally recorded lower initial baseline data.

Almost 70% (9 out of 13) of teachers' classes recorded notable increased scores across the four main areas of research: science identity, science trajectories, science agency and out-of-school science. A measure was also included to check the extent to which children felt that their teacher was implementing the approach, asking children to rate the extent to which they felt that their teacher "linked science to their lives" in class. Across the 13 teachers, there was a 7.5 percentage point increase in agreement with this statement, with six classes recording more than a 10% increase in agreement levels and one teacher seeing a 35% increase in agreement.

Comparing each child's responses on the pre- and post- surveys, the research revealed evidence that teachers' implementation of the PSCTA resulted in positive learner outcomes across several different areas including: increased science identification and recognition; increased interest in continuing with science; more regular engagement with science outside school; and increased student agency in science lessons.

"The more you use the approach, the easier it is to spontaneously integrate into your lessons without overthinking during planning. A lot of the time now, the children come up with contexts and start linking the topic to things that they are aware of. So it's about not overthinking 'what examples I should use for this' because it's quite surprising how much the children can actually do that for you within the lesson! As the years go on, we will collect a bank of ideas created for us by the children."

(Year 4 teacher, Midlands)

Technical information

Not all participating teachers were able to collect and return pre/post survey data – hence the quantitative data reported covers only 13 out of the participating 20 teachers.

Note that while the numbers are too small to do a statistical significance test, these findings are based on the spread of the error bars across the factor scores for different grouped questions. If the error bars do not spread across zero, this signifies that most of the data points lie on only one side of the 0, giving a significant score. Additionally, simple percentage differences are also reported here.

My teacher links science to my life

Before the approach **35%**

After the approach **43%**

Tell someone at home about what they have learnt in science at least every month

Before the approach **60%**

After the approach **71%**

Knowing a lot about science can help you get a job when you are grown up

Before the approach **50%**

After the approach **57%**

Increased science identification and recognition: 'science identity'

Students were asked (both before and after the intervention) about the extent to which they feel they are "science-y", their teachers or friends recognise them as being "science-y", and they believe they are good at science. Together, these three areas can provide an indication of a child's 'science identity'. Following implementation of the approach, the research found that:

- Approximately half (6 out of 13) of the classes recorded increases in children's scores on these questions, suggesting that children's science identities had been supported by the approach.
- Two classes saw a particularly striking difference in the pre/post percentage of children feeling that they are 'good at science', with one recording a 25% increase in agreement with this statement.

"The approach for me is all about finding the right balance. There are some children in my class who see themselves as really "science-y" and have something to say about every question I ask. It's really nice that they do so, but they will dominate the entire classroom discussion if you let them. My effort has been to find ways to involve those who don't speak up, and to ensure that their voices are heard. I also encourage all my students to appreciate, value and respect each other's contributions."

(Year 4 teacher, London)

"This approach has really made me rethink what I might do unconsciously as a teacher in terms of my perception of the children. How do I view them as science students? I may sometimes think, 'Oh, these children are really good at science', but it's probably because they're the loudest ones. The PSCTA has made me realise that so much of this is about perception and expectation."

(Year 5 teacher, London)

Increased interest in continuing with science: 'science trajectory'

Children were asked (in pre- and post- surveys) about the extent to which they want to become a scientist when they grow up, and whether they want to keep learning about science in the future – their 'science trajectory'. The research revealed that:

- Over half of the classes (7 out of 13) recorded increases in the percentage of children aspiring to become a scientist and wanting to keep learning about science in the future.
- One teacher's class recorded an increase of 23% in agreement with the statement: When I am older, I want to be a scientist. In this class, there was also a marked decline (38%) in the number of students who disagreed with the statement. Two further classes recorded 20% and 17% decreases in disagreement, respectively.

"I was quite sceptical to start with, but I saw it made such a huge difference! The approach totally changed the classroom experience for those who typically don't raise their hand. I saw these children sit up in their chairs, look straight at me, and I could see them thinking, 'Yes, I am part of this – I have something important to say'. Being able to share their own life experiences and knowledge with the other children gave them a huge sense of achievement."

(Year 4 teacher, Midlands)

Increased engagement with science outside school: 'out-of-school engagement'

Students were asked about the extent to which they engage with science in their spare time, particularly how often they think about science, read science books or magazines, watch science-related YouTube videos, look up science on the internet, etc. Taken together, these questions gave researchers a measure of children's out-of-school engagement with science. Key findings were:

- Over 60% (8 out of 13) of the teachers' classes recorded increased levels of engagement with science outside school.
- For the statement 'I watch science programmes on YouTube or TV', three classes recorded an increase of more than 20% in children reporting that they do so 'every week'. Impressively, in one teacher's class there was an increase of 71% expressing that they watch science programmes on YouTube or TV 'every week'.

"This approach really helped us to engage the families. For example, during lockdown we asked the children to record their findings from their experimentations in whatever way they wanted. We let them lead, rather than insisting on writing things down in the regular way.

We noticed immediately that family members were getting involved. When the children were uploading photos or videos of their results, they had a brother, a sister, a mum or a dad joining in with them. The children were automatically having rich science conversations with their families!"

(Year 6 teacher, South Coast)

Increased agency in science lessons: 'science agency'

Students were asked about the extent to which they share their ideas in the science classroom. Their responses were used as an indicator of the level of engagement and agency they experience in science lessons. Comparison of the pre- and post- survey data showed that:

- Just over half (7 out of 13) of the teachers' classes recorded an increase in children's science agency.
- Three classes recorded an increase of more than 20% agreeing with the statement 'I often share my ideas in science lessons'.

"Last year, before I'd started the approach, I would begin with the learning objective. I would be the one to share the information and the students would be the ones to do the work. But now, while I know what I want them to get out of the lesson, they come up with the questions and they devise the investigations and experiments too. Releasing the reins and letting them take control absolutely makes the children feel more engaged than they would have been."

(Year 4 teacher, London)

"Knowing the children better has really helped me to help them. Knowing about their interests, their families and communities, their hobbies and their friends helps me to personalise their learning. I decided to use the attendance registration time as an opportunity to learn something more about the children. I would even ask silly questions like, 'What's your favourite takeaway?' This helps me to personalise all the subjects, not just science."

(Science lead, Midlands)

The impact on teachers

As well as recording the impact of the PSCTA on students, data was also collected that helped better understand the extent to which teachers experience an impact on their own experiences and practice. While the impact data is necessarily limited, it has generated several useful insights:

100%	of the participating primary teachers agreed or strongly agreed that their practice had developed as a result of the approach.
92%	of the participating primary teachers involved in the project agreed or strongly agreed that their class's overall science learning had positively evolved.
93%	of the participating primary teachers felt that their understanding of equity-based teaching and learning had developed as a result of the approach.
100%	of the participating teachers would recommend the approach to other teachers.

The project had two phases, with the first phase involving only 10 fellow teachers for a year, as they helped to co-develop and test the approach. In the second year, these teachers then cascaded the approach to a buddy teacher in their school. Teachers who had participated for longer tended to record higher baseline and endline data scores. On the other hand, within a year of implementation, huge shifts were observed in the data from the classes of buddy teachers – indeed, the greatest improvement in student scores was recorded in the class of one of the buddy teachers.

While all teachers attempted the whole-school approach, this was not easy to achieve during a year of multiple lockdowns. Nonetheless, the greatest positive increases in student scores were found in schools that had prioritised a whole-school approach. For instance, the school that managed to implement the whole-school approach most successfully also recorded notable positive increases across all key student outcome areas (identity, agency, trajectories and out-of-school engagement) within both of the participating teachers' classes. This was reinforced by extensive collaboration between the two teachers.

"I loved working with another teacher – seeing how they interpreted the approach and how it impacted their classrooms. I would have long discussions about the theory of the approach with my buddy teacher, and it was wonderful to see that many of the things that she was doing were already part of the science capital approach, without her realising it. Working together helped her to recognise these practices and continues to strengthen them!"

(Year 2 teacher, South West)

“As I discussed my tweaks with my buddy teacher, I looked at the lesson in a way that I would never have approached it.

Two heads are better than one!”

(Year 6 teacher, London)

5. Whole-school implementation of the PSCTA

Using the PSCTA, individual classroom teachers can make a real difference to their children's science capital, learning and engagement. When change happens at a whole-school level, the effects can be even more powerful and can make a notable and sustained difference to children's experiences and outcomes. Moreover, when the school's senior leadership team (SLT) and colleagues are supportive, teachers can feel more confident about innovating in the classroom. Sharing experiences with colleagues is also valuable as a form of reflective practice and an important part of a school's learning culture.

Have a go

An exercise to help implement a whole-school approach

- Discuss the PSCTA with your head teachers so that they understand what it is and why you would like to introduce it at school. Make sure you have their interest and support.
- Include the PSCTA in the school improvement plan.
- Run an extended staff meeting or INSET day to introduce colleagues to the approach, share resources and discuss the ideas. Make sure everyone has a chance to explore the ideas and 'buy in' to the approach.
- Map your specific school needs and priorities (e.g. greater parental engagement, student-centred learning) in relation to what the approach offers.
- Find gaps in your existing plans to see how the approach can support and build better ways of serving the children (e.g. lack of attention to equity in policies).
- Advocate for the approach during external meetings with the governors, school management or other teachers.
- Showcase the approach during an Ofsted inspection.
- Include classroom observations once per term to reflect on science capital-informed teaching across the school.
- Ensure that all staff have regular opportunities to discuss, reflect and share ideas and progress in relation to implementing the approach.
- Pair or group teachers so they can provide 'buddy' support to one another.
- Conduct annual whole-school PSCTA student surveys (see Appendix B) to track progress and record gains.
- Share and celebrate children's voices, experiences and progress in science with the entire school community.

Exercise 4: Implementing the PSCTA at whole-school level

Example

A teacher's story: changing the school culture to promote a whole-school implementation

A Year 6 teacher realised that using the PSCTA in her science lessons considerably increased the excitement levels of the children, particularly when she focused on personalising and localising, and making space for student voices. Initially this would unsettle the teacher, who felt that a noisy class distracted from the approach. However, over time she negotiated an understanding with the class regarding how this excitement should be expressed and shared, co-creating ground rules to ensure that students could hear each other. This allowed everyone to speak and share their views and experiences (with enthusiasm!).

The teacher shared this change to her approach with her colleagues and SLT – she wanted them to be aware that, while her science lessons might sometimes seem noisy, she was productively engaging children and experimenting with the approach. The teacher was given support to try out the new approach, which reduced her concerns about noise. Slowly, as she continued to share her experiences with her colleagues, the PSCTA became accepted within the wider school culture, as other teachers also began to appreciate that a quiet classroom is not necessarily an engaged classroom. Other teachers also became more comfortable eliciting the student voice and became more able to recognise the difference between active engagement and noisy disruption.

Example 11: Positively impacting school culture using the PSCTA

"I found that a good way to develop the approach for the whole-school was to start sharing what I was doing with other teachers, children and parents – not just telling them, but showing them and putting it into practice. For example, rather than just celebrating my students' work in class, I began celebrating the science work of some of my least engaged children every week on big boards by the lunch hall. My colleagues and I would try the same lesson (with PSCTA tweaks) and share our findings with each other. This supported my own learning of the approach and also familiarised my school, helping to bring them along on my learning journey."

(Science lead, London)

Using a cycle of whole-school implementation

The figure below shows the cycle of PSCTA implementation, which enables teachers and schools to implement, operationalise and sustain the approach. At the core of the cycle is the PSCTA model of reflection and tweaking. In addition, resources such as the Equity Compass, student survey and reflection sheets (Appendix A, B and C respectively) support the implementation cycle. While the compass and reflection sheets can be used to enable reflective practice at any point, the survey is a tool for tracking longer-term impact at key points, such as the beginning and end of an academic year. These resources can be used by teachers as they develop and engage with the approach.

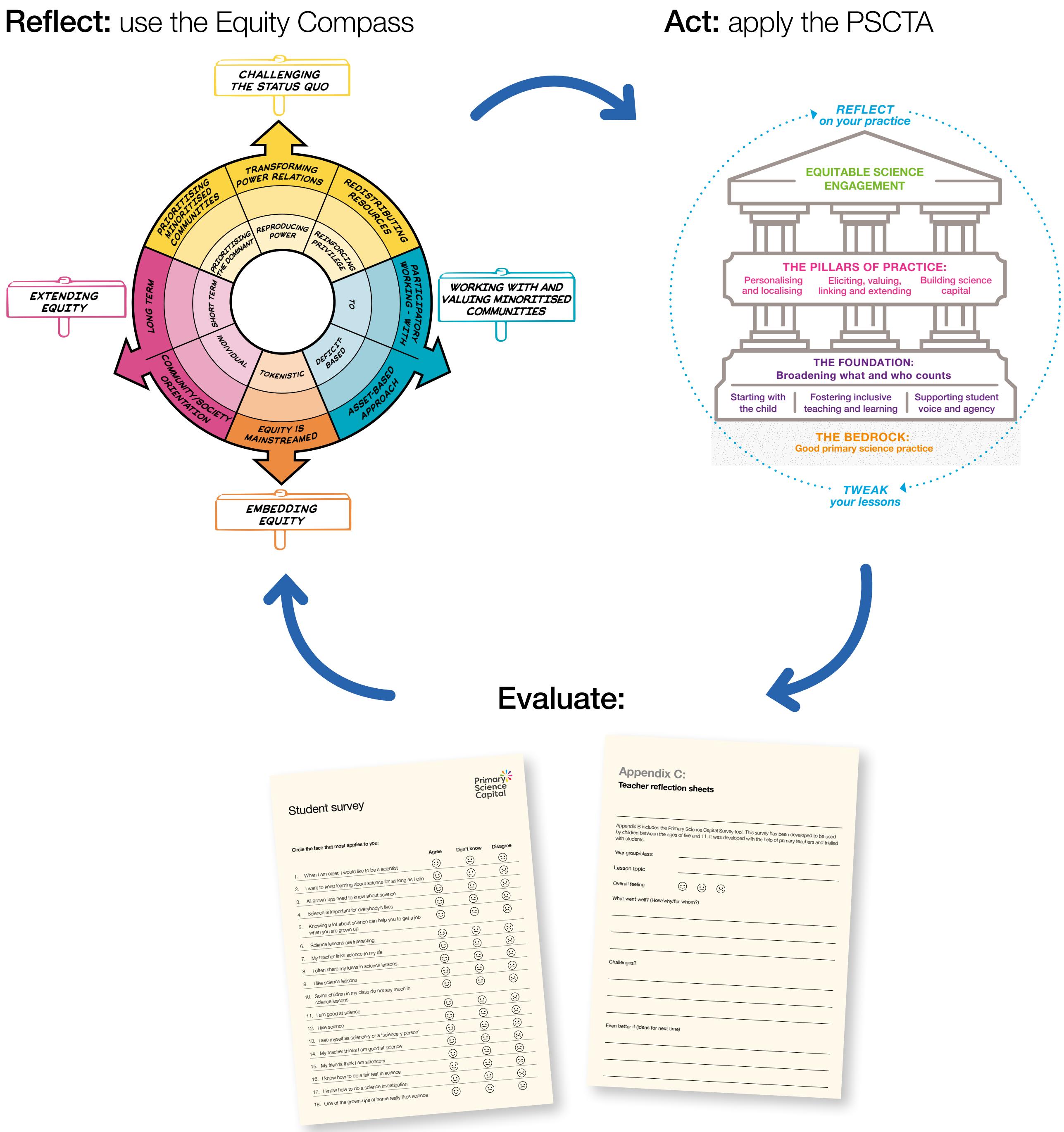


Figure 3: The PSCTA implementation process

A primary school's experience of the PSCTA

The science lead at a small, two-form school with around 300 children in total had been aware for some time that class teachers appeared to struggle with ensuring the active participation of all children in science. The science lead, along with the class teachers, had reworked their learning objectives and lesson plans to try to improve lessons, but something still seemed to be missing.

Teachers reflected that students often looked bored during science lessons. The science lead suggested implementing the PSCTA, and the SLT agreed to this plan. The science lead organised three staff meetings spread across the academic year and monitored the teachers' implementation of the approach. At the end of the year, staff identified some core issues, which then became their focus for the next year's implementation process (see Example 12).

Example

Introductory meeting (Autumn term)

The science lead and SLT invited a teacher trainer (well versed in the PSCTA) to present the approach.

The teachers were used to working with lesson plans that had been developed previously. However, they felt that the social justice mindset of the PSCTA provided a refreshing new lens and, importantly, gave them a way to centre the child when adapting lessons. They didn't have to throw away all their lesson plans, just tweak them from a fresh perspective.

Teachers were paired with a buddy teacher, and were encouraged to share successes, challenges and learnings with one another. Student surveys were conducted to establish a baseline.

Reflection meeting (Spring term)

The next meeting was dedicated to identifying successes and difficulties with the approach. The science lead observed science lessons to help identify what was working well, and what needed more training and embedding. One clear success was that teachers understood the importance of representation and ensuring that 'science careers' that they discussed included more diverse representation. Some teachers were also developing a good sense of using personalised and localised content.

However, many teachers were finding it hard to focus in their planning on the least engaged students. At this point, it was decided to extend the practice and dig deeper into the lives of these children. What were the barriers faced by the children? How could the school connect better with these students and help them engage with school science? Teachers decided to reach out more to families and communities to deepen their understanding of the children's lives.

End-of-year reflection meeting (Summer term)

In the third meeting, the science lead focused on the findings from the second round of student surveys (conducted at the end of the year), which showed that almost all children had improved perceptions of science and science lessons. Many teachers also highlighted the changes they saw in particular children, who seemed much more enthusiastic about science.

The science lead and SLT identified themes to focus on for the next year. For example, they had learned that many of the least engaged families experienced acute issues around resources. The schools conducted a needs assessment exercise and decided to look at their own resourcing practices, considering how schools can more actively support these families. Some teachers shared how they had also applied the approach in other subject areas and had found similar benefits. The school decided to rethink how an equity focus can be integrated into schemes of learning for all subjects.

Example 12: Whole-school implementation in action

6. Frequently asked questions

1. How will a busy primary teacher be able to implement the PSCTA? How much time and how many other resources does it need?

The approach does not require any new resources or content – it works with your existing curriculum. The main investment needed is time to understand the approach and reflect on your existing practice, and then to tweak your lessons using the PSCTA model. Most teachers find they can fit this into their existing lesson planning time, although it may take a little more thinking time at the start as you get to grips with the approach.

"In our school, we've taken a slow but collaborative approach. In the beginning, we focused on tweaking a couple of lessons in every unit to get the hang of it and slowly developed more lessons. We also tried to get everyone involved. For example, everyone would be in the staff room, eating and chatting, and that would be when a teacher would ask how they could make a particular lesson more 'personalised'.

Everyone brings their own experience to the approach, and this opens up so many different avenues. Building up slowly, but having all staff on board and familiar with the approach, makes the approach much more sustained and achievable."

(Science lead, London)

2. How does the approach meet Ofsted's expectations?

The PSCTA supports the aims of the primary science curriculum. It provides teachers with a framework for building equitable engagement among children. It encourages the asking of questions about the world around us and making sense of how scientific knowledge and skills can be instrumental in daily and future life.

Specifically, the PSCTA supports children's science identity and agency, which the *OECD PISA 2024 Strategic Visioning Report* highlights as key areas that science education needs to support and develop in young people. In addition, the PSCTA supports the following generic science enquiry skills across the primary phase:

- Asking questions
- Observing and measuring
- Planning and setting up different types of enquiries
- Identifying and classifying
- Performing tests
- Gathering and recording data
- Using equipment
- Reporting, presenting and communicating data/findings

3. Does 'starting with the child' mean that science content is sidelined or ignored?

Starting with the child does not mean that the objectives or aims of the curriculum are to be ignored. Rather, it encourages you to think about the engagement of all children, and to design teaching and learning opportunities that are appropriate for all the children in the class.

4. Where can I access professional development or training?

Although this handbook can be used as a standalone resource, teachers may find it particularly beneficial to access professional development support through an accredited regional coordinator. See our website for details. www.ucl.ac.uk/ioe/PrimarySciCap

5. Can I invite someone from your research team to come talk with teachers about the approach?

We are always very happy to hear from teachers and schools who are trying out the approach! We have produced a range of supporting resources for schools to use, including a short video introducing the approach. You will appreciate, however, that we have finite capacity to visit in person, so we try to prioritise regional and network events rather than individual schools, as this enables us to engage with more teachers, more efficiently. To find out more about our dissemination plans, resources, and contact details, please visit our website: www.ucl.ac.uk/ioe/PrimarySciCap


The more that you READ,
the more things you will KNOW.
The more that you Learn,
the more places you'll GO.
Reading
CAN TAKE YOU Anywhere!

7. Illustrative lesson plans

Examples of teachers using the tweak-and-reflect cycle

How teacher A adapted a year 2 biology lesson

Lesson objective: Notice that animals, including humans, have offspring that grow into adults (Animals, Year 2, KS1).

Teacher A's original lesson plan

Teacher Activity	Student Activity
Show video/presentation on how we change as we grow. Discuss with the children how they have changed as they have grown. Students are given images of humans of different ages and asked to arrange them from younger to older.	Take questions from students about the video/presentation. Students share their stories about siblings. Students in groups arrange the illustrations of humans into different age groups.

Teacher A's tweaked lesson plan

Teacher Activity	Student Activity
Ask students the following question: "Who has a younger brother/sister/family member?" Ask how old were they when the new family member was born. Ask students to think about the differences between themselves and a younger child, and how we change as we grow.	Students share stories about siblings or younger children that they know. Students share changes that happen when we grow.
Show video/presentation on how we change as we grow. Highlight the points in the video that the students themselves similarly made.	Children think about how we are able to recognise younger and older individuals.
Having previously asked colleagues (teachers, teaching assistants) to bring in baby pictures, have a class activity to match the photo to the adult.	Children talk about how some features change (hair, height, weight, etc.) and some remain the same (skin colour, eye colour, shape of a smile, etc).
Linked art lesson: Ask children to create an image of themselves as a baby thinking about features that have changed.	

Eliciting students' own understanding

Value the students' contributions and their links to scientific information

Personalising and localising

Extend beyond the lesson

Teacher A's reflection sheet

How did the science capitalising of my lesson go?

Year group/class: Year 2 Lesson topic: Human offspring Overall feeling: ☺ 😐 ☹

What went well? (How/why/for whom?)

The tweak made a big difference to the way children engaged with the topic. Students shared childhood stories that they have heard from their parents. For example, Nicole talked about how her brother got his teeth, and she lost her first tooth the same day! This was a great story, which I was able to focus on and link with the video I was showing. I also decided to extend the lesson and use the theme for my art lesson. Children drew impressive images of themselves!

Even better if?

Next year, I will aim to have more time to discuss the children's questions and allow them to research the issues that they care about. For example, Leo was keen to learn about muscle development. This way I can build the science learning around the things that the children are interested in, and help them develop the agency to be self-directed learners.

How teacher B developed a year 6 lesson on electricity over several reflective cycles

Original lesson objective: Understand renewable energy sources (Electricity, Year 6, KS2).

Teacher B's original lesson plan

Teacher Activity	Student Activity
On a whiteboard, write down the different ways in which electricity is generated. Introduce the terms 'renewable' and 'non-renewable' and ask children to identify which form is which.	Students learn the terms 'renewable' and 'non-renewable' and some of the ways electricity is produced. Working in pairs or small groups, students discuss which forms of electricity production are renewable or non-renewable.
Divide the group into two and allocate one group to rehearse the advantages of renewable energy sources, and one group to rehearse the disadvantages of renewable energy sources.	Students in two groups debate the advantages and disadvantages of renewable energy sources.
Watch video links with additional information and highlight benefits of using renewable energy. Model how to complete research tables and help students list advantages and disadvantages of different forms of energy (fossil fuels, biofuels and nuclear power).	Using information provided, students complete research tables.

Teacher B's first tweaked lesson plan

Teacher Activity	Student Activity
Invite the school caretaker, Mr Williams, to join the lesson. Introduce Mr Williams as somebody whose work often involves aspects of science. Ask Mr Williams to explain how the school uses electricity and what decisions he makes about electricity providers (e.g. the recent installation of solar panels on the roof of the main block).	Students go out into the playground and count the solar panels on the roof.
Invite the children to ask their own questions to Mr Williams, and to talk about their knowledge of electricity and how it is used in their lives.	Students ask questions that reflect their personal interests. In addition to talking about the school's supply, students share about the electricity usage in their own lives and communities.
Explain the terms 'renewable' and 'non-renewable', and invite children to discuss which term applies to the school's electricity supply.	
Watch video links with additional information and highlight benefits of using renewable energy.	Using information provided, students complete research tables.
Model how to complete research tables and help students list advantages and disadvantages of different forms of energy (fossil fuels, biofuels and nuclear power).	
Ask them to comment on which form of electricity production they would prefer the new library being built down the road, to use.	Students express their own opinions.

The building science capital element of 'who we know'

Supporting student voice and agency

Eliciting, valuing and linking

Supporting student voice and agency

Teacher B's reflection sheet

Teacher B's reflection sheet: How did the science capitalising of my lesson go?

Year group/class: **Year 6** Lesson topic: **Electricity – lesson 8** Overall feeling:

What went well? (How/why/for whom?)

During the caretaker's classroom visit, children were incredibly engaged. They are all familiar with Mr Williams and felt comfortable asking him many questions and speaking out in his presence. Children were particularly interested in how the move to solar panels had reduced electricity bills for the school. Mr Williams compared earlier bills to the current costs. The class was fascinated to hear how much electricity can cost and it prompted many to say they would now be turning lights off whenever they left the room!

Even better if?

While students seemed engaged, it felt as though this was still led by my own ideas about electricity. While localised to students' school experience, I felt there were limited examples from their own lives. When students were asked to share about electricity usage in their own lives, I felt there were some interesting voices coming up – but I didn't get the time to explore this fully. I think it might be better if I started the lesson with more personalised experiences of electricity, and to encourage them to think about the role electricity plays in their lives.

Teacher B's second tweaked lesson plan

Teacher Activity	Student Activity	Annotation
Invite children to share their knowledge of electricity, what we might do when we don't have easy access to sockets, and what forms of electricity production they might have experienced.	Students reflect on, and share their own experiences relating to, electricity.	Starting with the child
Invite children to reflect on two local (and familiar) places – their own home and a local nursery; a nearby shopping centre and the local secondary school – and to think about how much electricity each might use.	Students begin to think about the ways different buildings/ organisations use electricity, and recognise that choosing electricity providers is an important everyday issue.	Personalising and localising
Ask if they know where the electricity comes from (prompt with descriptions of solar panels, or generators, or pipes/ pylons, etc). Explain the terms 'renewable' and 'non-renewable' and invite children to discuss which term applies to these buildings' electricity.	Children discuss whether they think the buildings they have considered should be supplied by renewable or non-renewable energy sources, and give a reason why.	Fostering inclusive teaching and learning Supporting student voice and agency
Invite Mr Williams (the school caretaker) to join the lesson and introduce him as someone whose work often involves science.		Building science capital
Encourage the children to ask their own questions to Mr Williams. Invite Mr Williams to explain the school's recent decision to move to solar panels, and the costs for the school.	Students ask their own questions to Mr Williams. At break, students are encouraged to count the number of solar panels on the roof. For homework, students and parents/carers count the number of buildings they see with solar panels (or wind turbines) on their way to and from school. Students apply their science knowledge, experiences and views to other spheres of their lives.	Support student voice and agency Extending beyond the lesson Supporting student voice and agency
Linked literacy lesson: Ask the children to write a persuasive piece of communication (a poster, a tweet, a letter) to lobby the owners of a local building to change their supplier of electricity.		Extending beyond the lesson

Teacher B's reflection sheet

Teacher B's reflection sheet: How did the science capitalising of my lesson go?

Year group/class: **Year 6** Lesson topic: **Electricity – lesson 8** Overall feeling:

What went well? (How/why/for whom?)

This year, the electricity lesson felt much more student-led! In the first half of the lesson, students came up with some amazing examples of electricity in their own lives. Cameron talked about how he used battery torches during camping in the woods when there was no other source of electricity. Sameera talked about her summer vacations in Lahore, where they used petrol generators whenever there were power cuts! Having already discussed their own examples, they were curious to learn about the school's electricity supply, so it worked well to bring in Mr Williams at a later stage!

Even better if?

I think the personalised experiences of electricity really worked well. The lesson could be improved even further if there was a way that students could engage with their own ideas more over time to help support their agency. And, while we started thinking about the wider issues around renewable energy, I think students would have liked more time to discuss their understanding of global issues and climate change (as they have all heard about this on social media, in assemblies, etc.). Another lesson could help students to think about how they can further develop their environmental agency.


easy
hard
work

How teacher C developed a series of year 4 lessons on habitats

Teacher C wanted to explore the PSCTA in a series of lessons. Apart from making tweaks in each of her planned lessons, she decided to use a more sustained approach in which each lesson builds on reflections from the previous one. The following is an example of four Year 4 (KS2) lessons on the topic of 'living things and their habitat'.

The overall aim was to support the learning goal of: 'Pupils explore examples of human impact (both positive and negative) on environments, for example, litter or deforestation. (Year 4, programme of study, gov.uk)'.

Teacher C's Lesson 1: Exploring the topic through students' own experiences

- As a pre-task, students were asked to list as many things as they could think of that they regularly throw away into rubbish bins. Secondly, students were asked to notice litter in the streets around their homes.
- During the lesson, students worked in small groups to compile a shared list of rubbish items. They could choose to write them down, or draw them. These drawings and lists were shared with the whole class and then put up on the bulletin board.
- Students were encouraged to share or comment upon surprising items in their own or their peers' displays. They asked questions about what is rubbish, and what is not; whether certain things should be thrown away or not.

Some reflections

Today's lesson felt very open-ended and sometimes in the discussion the children said things that weren't very relevant to the topic of rubbish. But I still tried to stop myself from correcting or directing the conversation. I wanted to give the students the chance to speak and comment on others' suggestions. The highlight of the class was Ron's contribution! Ron always tries to make 'smart' comments and distracts the class, but today it was so interesting to hear his story. He talked about himself and his friend Dan, who cycle around their block every evening and sometimes pick up things that they find lying around. He had so much to say about the things he finds! He often picks up all sorts of bottle caps and has a collection of them. He even showed the class some of them that he had in his bag! I think the class's interest in his collection really boosted Ron's confidence. I have asked Ron's mum to take a picture of Ron on his bike and the places where he finds bottle caps. I've also asked him to bring his collection into class. In the next lesson, I plan to focus on Ron's knowledge of bottle caps – it will be interesting to see how he responds!

Teacher C's Lesson 2: Exploring how children categorise waste items

- I shared the photos that Ron's mum had sent me of "Ron in action!"
- I invited Ron to talk about his collection and how he organised it. As a class, we talked about differences and categorising.
- Next, working in their small groups, students discussed differences between their lists of rubbish items and tried to come up with a way of sorting them into categories.
- I showed them the local council leaflet explaining waste categorisation.

Some reflections

Ron was so engaged and there was a sense of pride in the way he presented his collection – really different from his typical body language. He sat up straight, the entire class listened and he spoke with pride!

When I shared the photos of Ron in action, some of the students could recognise the streets and said, "I live there!" or "I go to the shops there!".

When I showed them the council leaflet, the students were excited that they recognised the different types of bins! Josh explained what the colour of the bins meant.

Anya said, "My dad always wants to reuse all the packaging we get. My Lego's in old ice cream tubs."

I was now keen to explore what waste sorting/management meant for these students and their families. How could children advocate better practices in their homes and communities?

Teacher C's lesson 3: The Importance of recycling and waste awareness in school and community

- Working in the same small groups, the students looked again at how they had sorted their materials. As a class, we discussed whether any group had sorted along the principle of recyclable vs non-recyclable.
- We discussed the terms, and then the groups created further divisions of their items using these terms.
- We then watched a video about what happens to rubbish and recycled materials, before a group discussion about what we might do as a class.
- Students were then asked how they would like to present what they have learnt in these lessons.
- Students decided to make a big poster out of the rubbish/recyclable materials they found around the school and their homes.
- They decided to display this poster near the school gates to remind parents/carers, who stand there at collection/drop-off times, and the other children about the importance of recycling and not dropping rubbish. The class also presented their science learning and their poster at a school assembly, with Ron sharing his own story.

Some reflections

I was really excited by the decision that the students took to make a poster. When I started the lesson, I had no idea that children had so much enthusiasm and passion about the topic. Anya talked about re-using being important. Rashmi said that she had talked about 'reduce, re-use and recycle' in Eco-warriors, but that this hadn't yet been spread around the school. George and Ezra said that the class should lead the way!

Sharing with the whole school also helped other teachers to see how the PSCTA can lead to these interesting student-led outputs.

For next year, I decided to connect the lesson with The Wombles (Keep Britain Tidy) campaign. I also decided that I could localise the lesson even more by mapping litter around the local area and encouraging students to think about connecting this to the wildlife it might be affecting. My focus next year would be on student voice, agency and the larger community!

Appendix A:
The Equity Compass

Appendix A contains a reprint of the Equity Compass (teacher edition), a powerful tool to enhance your practice of the PSCTA. The Equity Compass was developed by the YESTEM project (www.yestem.org), a sibling research project to the PSCTA, which shares the ambition of supporting social justice in all science learning environments, from primary classrooms to out-of-school, informal science events. The YESTEM project has kindly allowed us to reproduce their summary of the Equity Compass in this handbook.

TEACHER EDITION

The Equity Compass: A tool for supporting socially just practice

YOUTH EQUITY + STEM

YESTEM Insight

What is the Issue?

- Inequity is an ongoing and important issue for schools. Research shows the impact of injustices on students' experiences, attainment, progression and well-being.

- At the same time, many teachers have limited support and training to address the complexity of inequalities.

'I looked at our inclusion policy and apart from one exception, equity isn't really a focus. That made me think more than ever that maybe I'm not the only one who hadn't given it enough consideration.' (Primary school teacher)

Whereas **equality** means treating everyone the same and providing everyone the same opportunities, an **equity** approach advocates for differential treatment of people according to need, while also recognising and valuing differences between people. A **social justice** approach seeks to change the structures and practices that create and maintain inequalities.

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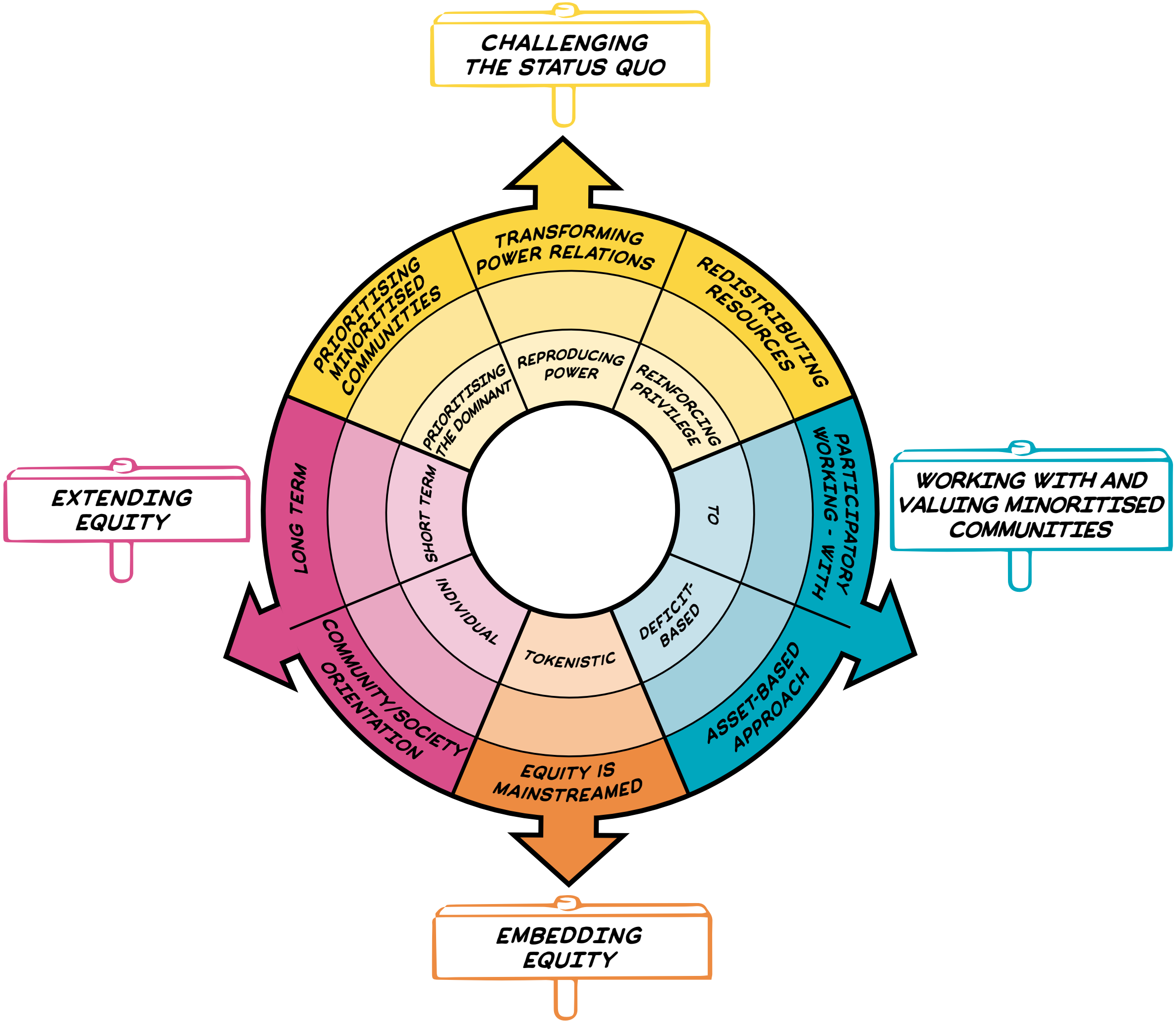
The Equity Compass: A tool for supporting socially just practice

- The Equity Compass is a tool that can help primary and secondary teachers and any support staff to **reflect on and develop their teaching, adopting a social justice mind set.** The tool aims to support teachers towards inclusive and socially just practice in relation to all areas of injustice and protected characteristics, including race, gender, sexual orientation, social class, disability, religion, etc.
- Adopting an equitable teaching approach is not just about *what* you do, but *how* and *why* you do it. The stance taken and the principles underlying a teaching approach can profoundly shape its potential for either reinforcing, or transforming, social inequalities. The Equity Compass can support teachers to **consider multiple dimensions of equity**, as represented by the eight dimensions of the Compass.



The Equity Compass was originally developed and tested in partnership with informal science, technology, engineering and mathematics (STEM) learning settings, such as science centres, zoos and afterschool clubs. It has since been applied by teachers and other educators more broadly (in primary and secondary schools, colleges and a range of informal learning settings), to the teaching of all subjects, and to educational funding and policy. The initial version of the Equity Compass included eight separate dimensions (axes) of equity; the version presented here was co-developed further with primary and secondary teachers, resulting in grouping the eight axes into four overarching areas.

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The Equity Compass: How to use it

- By attending to each of the eight dimensions, the Equity Compass can help teachers to better support all students, but particularly those from minoritised[1] communities.
- Each axis of the Equity Compass has a set of associated **Guiding Questions to help you to reflect on your teaching from an equity perspective.** For example, where would your current teaching, or a specific activity, sit on each axis? Being positioned closer to the outer edges indicates stronger equitable practice.
- The Equity Compass can be used to identify areas that you might like to **develop** further. For example, you might want to prioritise an area where your mapping sits closer to the centre of the Equity Compass. The Guiding Questions can help prompt the ideas about how future teaching could be planned in line with the eight dimensions of equity.
- You could also use the Equity Compass to **evidence your progress** towards more equitable practice by charting outwards movement on the axes. You could draw or map your current practice on to the compass and then repeat the exercise at a later point to map change (see an image below that shows how one of the teachers mapped her lesson on the compass). You could also use the worksheet provided in this insight to record your reflections and plans.

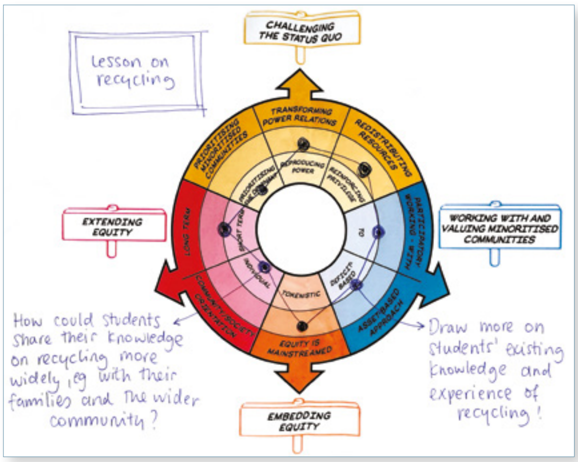

Image: An example of how one teacher mapped her lesson on the Equity Compass, adding her plans for further development of her practice.

How to adopt the Equity Compass at your school

- The Equity Compass can be used to consider anything from a school-wide programme, the curriculum, to an individual lesson or a specific activity.
- This tool is designed to be a **formative, not summative, tool** to support honest, on-going reflection. It is not about trying to get a 'perfect score' or ticking off areas as 'done'. Developing equitable practice is an on-going process.
- The Equity Compass could be used by teachers **independently**. However, it would be particularly effective to use it together with colleagues or as part of a **structured professional development**. For example, the tool could be championed by diversity and inclusion coordinators, used as part of professional development during in-service training (INSET) days or be a focus of a working group.
- Using the Equity Compass would be particularly valuable for newly qualified teachers and as part of initial teacher education or training programmes.
- Working with the Equity Compass can sometimes feel uncomfortable because it asks us to identify inequitable power relations and address privilege. However, these feelings can be useful and productive, and can indicate that the tool is being used in a reflective way. We would suggest that teachers—particularly those from dominant, privileged social groups—acknowledge and work with any feelings of discomfort and remember that these feelings can be useful (i) as a cue to remind you to foreground, listen to and learn from the experiences of others and (ii) to help collaboratively identify new ways forward.

[1] We use the term 'minoritised' as a shorthand for individuals and communities who are minoritised by dominant culture/society. Using 'minoritised' rather than 'minority' puts the emphasis on the systemic issues and structures that are failing to sufficiently recognise, support and value some people. People can be minoritised within a particular society depending on their race/ethnicity, gender, socioeconomic background, dis/ability, sexuality and other social axes. We acknowledge that labels are always imperfect and provisional and can vary in meaning and interpretation over time and between contexts, e.g., internationally, across different professional sectors, communities and between researchers, practitioners and young people.

The Equity Compass: A tool for supporting socially just practice

AREA	EQUITY DIMENSION	GUIDING QUESTIONS FOR TEACHERS AND SUPPORT STAFF
CHALLENGING THE STATUS QUO	TRANSFORMING POWER RELATIONS	Q Do students from minoritised communities feel that their school is a place where injustice in all forms (e.g., racism, sexism, ableism, class and LGBTQI+ prejudice, and so on) are being addressed and challenged? Q What opportunities are there for dialogue about power relations? How are students from more privileged communities supported to constructively understand and address their privilege and how their privilege impacts others? Q To what extent are 'dominant', hierarchical power relations between teachers and students, or between more privileged (White, middle class) students and less privileged (minority ethnic, migrant, working class) students being reproduced, or disrupted and transformed in your classroom and at your school?
	PRIORITISING MINORITISED COMMUNITIES	Q Whose interests, needs and values drive your teaching and the curriculum – those of the 'dominant' groups (e.g., school leadership, industry, economy, and privileged students) or those of students from minoritised communities? Q To what extent do you meet wider needs of minoritised students (e.g., hunger, safety) necessary for them to learn and engage?
	REDISTRIBUTING RESOURCES	Q How are minoritised students being supported in gaining resources (e.g., knowledge, skills, social networks, and chances)? Q Are opportunities predominantly directed at more privileged students, thereby reinforcing privilege? For example, do 'top set' students tend to get more opportunities? Q How do you understand the reasons for different outcomes between groups of students? For example, do you talk about learning and attainment 'gaps' or 'debts'[2]?
WORKING WITH AND VALUING MINORITISED COMMUNITIES	PARTICIPATORY WORKING - WITH	Q How participatory is your teaching/curriculum? Is teaching being primarily done 'to' and 'for' students, or are there opportunities to work 'with' students, particularly those from minoritised communities (e.g., to co-design activities and projects)? Q To what extent are minoritised students given opportunities to be recognised as producers of the knowledge/learning (not just consumers)? Who has ownership and voice within the learning?
	ASSET-BASED APPROACH	Q How are you valuing minoritised students' identities, cultural, experiential and home knowledge and experiences in your teaching? Might some knowledge and experiences get valued more than others? Q Are minoritised students' interests, knowledge, behaviours, identities and resources being recognised and valued (i.e., an 'asset-based' approach)? Are some minoritised students treated as lacking the 'right' interests, knowledge, behaviours, identities and resources (i.e., a 'deficit-based' approach)?

[2] The term 'education debt' was coined by an American pedagogical theorist and teacher educator Gloria Ladson-Billings to address the impact of fewer resources and opportunities available to minoritised students. She suggested that the phrase 'education gap' implies a deficit on the part of minoritised students who are blamed for their lack of academic achievement. A focus on 'education debt', as an alternative, helps us consider the injustices experienced by some students, prompting us to consider the ways to address and improve injustices. See Ladson-Billings' (2006) paper 'From the Achievement Gap to the Education Debt: Understanding Achievement in U.S. Schools', published in *Educational Researcher* journal.

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AREA	EQUITY DIMENSION	GUIDING QUESTIONS FOR TEACHERS AND SUPPORT STAFF
EMBEDDING EQUITY	EQUITY IS MAINSTREAMED	Q How mainstreamed, intentional and foregrounded are equity issues at your school? Are equity issues everyone's core business or are they minor, tokenistic and peripheral concerns (e.g., restricted to special programmes or a few passionate teachers)? Q Are equity issues embedded across all school practices, e.g., in time tabling, tutoring and family liaison and in one-off, occasional and extra curricula offers? For example, how are equity values considered, shared with and practised by school visitors and through drop down days, school visits, etc.?
EXTENDING EQUITY	LONG TERM	Q Are specific equity initiatives and experiences (e.g., diversity awareness events, diversity 'celebrations', careers education, mentoring, role-models, extracurricular clubs and school visits) one-off, short term, or longer-term? Q How does the school track the whole student experience to monitor equity issues and the impact of equity work?
	COMMUNITY/ SOCIETY ORIENTATION	Q To what extent does your teaching predominantly support the outcomes of specific, individual students? Does it also support more collective, community-oriented outcomes?

Photo credit: Primary Science Capital Project

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Spotlight on practice

Below are two examples from teachers who adopted the Equity Compass in their practice.

Using the Equity Compass to develop equitable teaching in a primary English class

A teacher in a multi-lingual London primary school used the Equity Compass to reflect on and develop her practice towards better supporting the minoritised students in her class.

She observed that her class was usually dominated by a handful of confident students, who would regularly share their experiences from extracurricular activities, trips with their families and knowledge of English literature they read at home. Other students, particularly some for whom English was not their first language, contributed less frequently. On reflection, the teacher realised that she sometimes interpreted these students as being less interested, having lower ability in the subject and as lacking a rich literary home environment. She also noted the absence of Black authors from the reading list.

Using the compass, she decided to take a more **asset-based approach**, to find out more about the children's lives and what they enjoyed reading, in both English and other languages and to value and integrate this into lessons. The next day, the teacher invited two usually quiet children to share their experiences and views as much as possible, encouraging them to share any folk tales or stories that they liked, "from either English or your own languages". After some initial reticence, the children engaged enthusiastically and the whole class enjoyed learning from one another.

A primary teacher reflected on the lesson afterwards: **"I was surprised what a difference could be made by such a small thing. You could see the pleasure on their faces that everyone was interested in their knowledge and views."**

The teacher started to plan how she might involve the children (through **participatory working**) to conduct an audit of library and reading books with a view to refreshing the collection to make it more diverse, inclusive and representative of their identities, interests and lives (**prioritising minoritised communities**).

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Spotlight on practice

Using the Equity Compass to support secondary school students' engagement with engineering

A teacher from a large, predominantly White British, working-class secondary school in the North of England shared an example of how they used the Equity Compass to rethink the annual 'career talk' given by a civil engineer who works at the local construction company to their Year 10 (students aged 14-15) science class. The engineer was an older White man, who would usually arrive at the school wearing his construction hat.

Using the Equity Compass, the teacher noted that the visits might be reinforcing stereotypical images of engineers (as white men in construction hats). Thinking about ways to **disrupt power relations**, the teacher discussed with the engineer how he might include a discussion about the diversity challenges in the sector and include broader representations of engineering and engineers – sharing some biographical profiles of Black and female engineers.

The teacher reflected how these sorts of career talks were typically one-off, isolated events and decided to think about how they could more regularly connect the science content in the curriculum to their students' lives, interests and futures as a **longer-term** approach.

They also reflected on how most STEM enrichment opportunities and interventions tended to be offered to top set students and/or those perceived by staff as being 'the most interested', who tended to be those from more privileged backgrounds. They decided to raise the issue at the next department meeting, with a view to forming a working group to develop a more inclusive approach aimed at **redistributing resources**. The conversation generated a lot of interest, both in the idea and the tool, resulting a few months later in the teacher being invited to share the Equity Compass and the department's work at the next whole school INSET day, to develop a school-wide approach to work towards **embedding equity**.

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The Equity Compass: Worksheet for reflecting on and developing equitable practice

AREA	EQUITY DIMENSION	REFLECTIONS ON MY CURRENT PRACTICE	MY PLANS FOR DEVELOPMENT
CHALLENGING THE STATUS QUO	TRANSFORMING POWER RELATIONS		
	PRIORITISING MINORITISED COMMUNITIES		
	REDISTRIBUTING RESOURCES		
WORKING WITH AND VALUING MINORITISED COMMUNITIES	PARTICIPATORY WORKING - WITH		
	ASSET-BASED APPROACH		
EMBEDDING EQUITY	EQUITY IS MAINSTREAMED		
EXTENDING EQUITY	LONG TERM		
	COMMUNITY/ SOCIETY ORIENTATION		

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About the YESTEM project

- Over four years, our project involved researchers, ISL educators and young people working in partnership to develop new understandings and insights about how ISL might better support equitable outcomes for young people aged 11-14 from minoritized communities.
- Our project partnership involved data collection in the UK and the USA with partners in two science centres, two community STEM clubs, a zoo and a digital arts centre.
- Overall, 260 young people and 30 practitioners took part.
- In the wider project we also conducted surveys with 2,783 young people (1,873 in the UK and 910 in the US).

Photo credit: Primary Science Capital Project

Additional resources

- See YESTEM Insight 1: The Equity Compass: A Tool for supporting socially just practice.
- Click here to see a 2-minute animation explaining the Equity Compass.
- We want to thank the research team and teachers working on the Primary Science Capital Project, who have provided valuable feedback and examples for this insight. Visit the Primary Science Capital Project website www.ucl.ac.uk/ioe/PrimarySciCap and follow them on Twitter @PrimarySciCap for future primary school resources.

Photo credit: Primary Science Capital Project

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Appendix B:

Primary Science Capital Survey

Appendix B includes the Primary Science Capital Survey tool. This survey has been developed to be used by children between the ages of five and 11. It was developed with the help of primary teachers and trialled with students.

The survey is a reflective tool for teachers to understand students' perspectives and experiences of school and out-of-school science. It is accompanied by a teacher's guide that supports you in conducting the survey in your classroom. The appendix also includes ways of interpreting and scoring students' science capital. Please note that our research team is constantly developing and refining the survey – and this appendix only provides suggested interpretations and scorings. These scores need to be understood in conjunction with your own understanding of students' lives and experiences, and used only for formative purposes.

For more information on the survey, visit our website at www.ucl.ac.uk/ioe/PrimarySciCap

The following pages are photocopiable, so please feel free to print them and use them in your own practice.

Primary Science Capital

Student survey

Your first name ______________________________

Your surname ______________________________

Name of school ______________________________

____

Name of your class teacher ______________________________

Year group (Please tick)

- ☐ Reception
- ☐ Year 1
- ☐ Year 2
- ☐ Year 3
- ☐ Year 4
- ☐ Year 5
- ☐ Year 6

Primary Science Capital

Student survey

Circle the face that most applies to you:

	Agree	Unsure	Disagree
1. When I am older, I would like to be a scientist	☺	😐	☹
2. I want to keep learning about science for as long as I can	☺	😐	☹
3. All grown-ups need to know about science	☺	😐	☹
4. Science is important for everybody's lives	☺	😐	☹
5. Knowing a lot about science can help you to get a job when you are grown up	☺	😐	☹
6. Science lessons are interesting	☺	😐	☹
7. My teacher links science to my life	☺	😐	☹
8. I often share my ideas in science lessons	☺	😐	☹
9. I like science lessons	☺	😐	☹
10. Some children in my class do not say much in science lessons	☺	😐	☹
11. I am good at science	☺	😐	☹
12. I like science	☺	😐	☹
13. I see myself as 'science-y' or a "science-y' person'	☺	😐	☹
14. My teacher thinks I am good at science	☺	😐	☹
15. My friends think I am 'science-y'	☺	😐	☹
16. I know how to do a fair test in science	☺	😐	☹
17. I know how to do a science investigation	☺	😐	☹
18. One of the grown-ups at home really likes science	☺	😐	☹

Student survey

Tick the answer that shows roughly how often you do these activities:

	Every week	Every month	Once or twice a year	Never
19. Someone at home tells me science is important	☐	☐	☐	☐
20. I tell someone at home about what I learnt in science at school	☐	☐	☐	☐
21. I draw or write about science	☐	☐	☐	☐
22. I go for nature walks	☐	☐	☐	☐
23. I think about science in my spare time	☐	☐	☐	☐
24. I go to a zoo or aquarium or city farm	☐	☐	☐	☐
25. I go to a science centre or museum	☐	☐	☐	☐
26. I watch science programs on Youtube or TV	☐	☐	☐	☐
27. I use science kits	☐	☐	☐	☐
28. I look up science things on the internet	☐	☐	☐	☐
29. I read magazines or books about science	☐	☐	☐	☐
30. I go to a lunchtime or after school science club	☐	☐	☐	☐

	Yes	Don't know	No
31. Does anyone in your family have a job that involves science?	☐	☐	☐

32. If yes, who in your family has a job that involves science?

☐ Parent/carer ☐ Grandparent

☐ Other family member (eg uncle, aunt, grown up brother or sister, cousin)

33. What do you want to be when you grow up?

Teacher guidelines for conducting the Primary Science Capital Survey

Thank you for doing this survey with your class!

It has just over 30 questions:

- The survey begins by asking children to fill in their first/last name.
- The next section comprises 18 questions asking about children's perceptions of science, which they answer by circling whether they agree, are unsure or disagree with the statements provided with the statements provided.
- The next section contains 12 questions asking about the frequency of children's science-related activities.
- The survey ends with three questions, one of which asks them to think about what they might want to do when they are grown up.

The survey will need to be completed individually by each child (i.e. one completed survey per child, no group responses).

An adult may read out the question for children (see below for a list of additional notes and examples to help teachers support children in interpreting the questions) and children will then mark their responses on the sheet. Teachers can choose whether or not they want to complete the entire survey in a single session or spread it out over more than one session. Please use the information below about each of the questions, in case children need any clarification.

Section 1: Background questions

Name: Please make sure that each child's first and second name is written in the spaces provided at the top of the survey.

Name of your class teacher: Please write the name of the class teacher here. Very young children are welcome to leave this blank.

Year group: Please add information about the students' year group.

Section 2: Science capital-related perceptions

☺ Agree ☹ Unsure ☹ Disagree

- Children may need to be provided first with an explanation of these three smiley faces: agree, disagree and unsure.
- You can use hand gestures (thumps up/thumbs down/so-so) to explain further if students agree, disagree or are in the middle.
- Please emphasise to children that there are no ‘right’ or ‘wrong’ answers, and they should choose an answer that they feel is closest to their own thinking.

1. When I am older, I would like to be a scientist
   - Children can answer this question based on whatever they think a ‘scientist’ is. By ‘older’ we primarily mean as an adult, but children can interpret the question in whatever time frame makes sense to them.

2. I want to keep learning about science for as long as I can
   - If necessary, you can provide examples. For example, would you still want to learn science when you are 17 or 18, or older than that?

3. All grown-ups need to know about science

4. Science is important for everybody’s lives

5. Knowing a lot about science can help you to get a job when you are grown up

6. Science lessons are interesting
   - Children might need to give a general/overall response here – obviously, some lessons will be more interesting to them than others. On the whole, do they find science lessons interesting, or not?

7. My teacher links science to my life
   - Ideally, add the name of the teacher here (it may be yourself!) – e.g. “My teacher (Mx X), links science…” If the children have more than one science teacher (e.g. a class teacher and science specialist teacher who co-teach), then please select one and name them (whoever you feel is most appropriate, whoever delivers the majority of the lessons or whoever is most involved in implementation of the PSCTA).

8. I often share my ideas in science lessons
   - Sharing ideas can include putting up your hand and answering questions in class, or talking with partners/in small groups – any way in which ideas relevant to the topic are shared (not sharing random/off-topic/distracting ideas though!)

9. I like science lessons

10. Some children in my class do not say much in science lessons

11. I am good at science

12. I like science

13. I see myself as ‘science-y’ or a “science-y’ person’
    - If children have difficulty with this, you can reframe this as ‘into science’ (e.g. I am into science – similar to when children might say they are into sport or art). This is different from saying ‘I like science’ or ‘I am good at science’. It is trying to get at a sense of connection and identification with science.

14. My teacher thinks I am good at science

15. My friends think I am ‘science-y’
    - Here again, you can say ‘into science’.

16. I know how to do a fair test in science
    - If children in your classroom are not aware of fair test for any reason, please keep a note of that. They can still fill in ‘disagree’, but please ensure that the next question (Q17) is completed.

17. I know how to do a science investigation

18. One of the grown-ups at home really likes science
    - You can explain that this can include their parents or carers at home, or it can be adult siblings, grandparents, or any adult who lives in their household.

Section 3: Frequency of science capital-related activities outside school

- If children have difficulty with these questions, you can provide some references. Encourage students to think about the answers in terms of every weekend/half-term holidays, if that helps.
- If children say they did it 'once' – ask them to mark 'once or twice a year'
- In this section, it is important to refer to the examples provided under the questions. For example, students might not automatically equate science to TV, but when reminded of particular examples, they may be able to answer.

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19. Someone at home tells me science is important.

---

20. I tell someone at home about what I learnt in science at school
    - For example, talk about things they've read, learned, done or seen that are connected with science.

---

21. I draw or write about science
    - We are primarily asking about what children do at home here – not at school.

---

22. I go for nature walks
    - Again, at home, not through school.

---

23. I think about science in my spare time
    - Here we mean at home in their free time, not at school. But it would count if they are thinking about science during break or lunchtime, for example.

---

24. I go to a zoo or aquarium or city farm
    - Out-of-school activities, not school visits.

---

25. I go to a science centre or museum
    - Out-of-school activities, not school visits.

---

26. I watch science programs on Youtube or TV
    - Please feel free to provide examples for children *(e.g. Naomi's Nightmares of Nature; Operation Ouch; Nina and the Neurons, Deadly 60; Science Max, David Attenborough, Seven Worlds One Planet, Bill Nye the Science Guy.)*

---

27. I use science kits

- Again, out-of-school use is what we are looking for. Children may not be aware of the term 'kit' so you can give examples of the following: make slime, grow crystals, use a microscope, kitchen chemistry sets, etc.

28. I look up science things on the internet

    - Again, outside school.

29. I read magazines or books about science

    - For example, *Science and Nature* magazine, *Whizz Pop Bang*, books about space, dinosaurs, nature, etc.

30. I go to a lunchtime or after school science club

    - There may not be a science club in school, but please still ask this question, as students may attend a club outside school. This question is looking for regular attendance. If students have attended a one-off event such as a science party, then they could tick 'once or twice a year' but we would recommend not prompting around parties and one-off activities.

Section 4: Details about parents' jobs and self-aspirations

31. Does anyone in your family have a job that involves science?

    - Children may need some support with answering this question. Jobs can include science and medicine jobs but we are also interested in the extent to which children perceive jobs as being to do with science (e.g. it doesn't matter if they don't think 'nurse' is to do with science). You could ask children to think about the main adults in their family/household – do any of them have jobs that are connected with science?

32. If yes, who in your family has a job that involves science?

    - Children may have different family backgrounds (two mothers/two fathers or carers). Encourage them to think about their family while answering this question, regardless of whether it fits into these categories.

33. What do you want to be when you grow up?

    - Children may need support with writing their answers.

Using the Primary Science Capital Survey as a reflective tool

This survey is not to be used as a form of assessment, but rather as a tool to help you reflect on your students' identification and engagement with school science. It will be useful in identifying areas that may need attention and will also help you to see how your own practice is evolving.

The survey captures seven core characteristics of science capital. Each survey response relates to one the of these characteristics. In addition, there are two questions that help teachers to understand the impact of their own approach. We encourage you to look through your students' responses to help you reflect on which area you may want to focus on when using the PSCTA.

Core characteristic	Related survey responses
1: Interest in science [5 responses]	Q9: I like science lessons Q12: I like science Q6: Science lessons are interesting Q2: I want to keep learning about science for as long as I can Q20: I tell someone at home about what I learnt in science in school
2: Science outside lessons [7 responses]	Q26: I watch science programmes on YouTube or TV Q29: I read magazines or books about science Q28: I look up science things on the internet Q23: I think about science in my spare time Q21: I draw or write about science Q27: I use science kits Q30: I go to a lunchtime or after-school science club
3: Science identity [6 responses]	Q8: I often share my ideas in science lessons Q7: My teacher thinks I am good at science Q11: I am good at science Q15: My friends think I am 'science-y' Q13: I see myself as 'science-y' or as a 'science-y' person Q1: When I am older, I would like to be a scientist
4: Science outside the home [3 responses]	Q24: I go to a zoo or aquarium or city farm Q25: I go to a science centre or museum Q22: I go for nature walks
5: Valuing science [3 responses]	Q4: Science is important for everybody's lives Q3: All grown-ups need to know about science Q5: Knowing a lot about science can help you to get a job when you are grown up
6: Science in the family [3 responses]	Q31: Does anyone in your family have a job that involves science? Q18: One of the grown-ups at home really likes science Q19: Someone at home tells me science is important
7: Science literacy [2 responses]	Q16: I know how to do a fair test in science Q17: I know how to do a science investigation
8 Understand your own impact [2 responses]	Q10: Some children in my class do not say much in science lessons Q7: My teacher links science to my life

Scoring the Primary Science Capital Survey

To further support your practice of the PSCTA, you can calculate science capital 'scores' for your class. We have identified 11 key survey responses that can be used to create a primary science capital score for each child who completes the exercise.

The following science capital 'index' is a set of 11 questions that form a subset of the full Primary Science Capital Survey. Initial analyses were conducted to explore whether some survey responses were more intrinsic to science capital than others. These analyses (described below) identified 11 responses as being particularly key. In addition, there was interest in developing a way to measure science capital that would be simpler (and shorter) to administer than the full survey, and would result in a score that could then be categorised as low, medium or high. Consequently, the 11 questions that emerged from the original analyses were used to form the index.

It is important to note that this index is not comprehensive because it does not ask about the full range of activities, attitudes and connections that comprise science capital. The index is useful as a formative measure to achieve an overview of the distribution of science capital across a wide range of students. At the same time, because it is short and not comprehensive, it is not well suited to measuring the impact of a single intervention in a particular area that is not covered by the specific responses that make up the index. Consequently, an intervention could have an impact without actually affecting an individual's score on the index. It is, however, useful for providing a baseline measure that might identify a given intervention's starting point.

During analysis of our project scores, we used 'low science capital' to describe participants with a score below 9. Scores between 9 and 18 were described as having 'medium science capital' and anyone scoring above 18 was described as having 'high science capital'. These indicative ranges are not to be used to categorise or label individual children, but they may be used as a general barometer of science capital in your class.

The responses (and scorings) that formed this measure are shown on the next page.

1. Survey Q2: I want to keep learning about science for as long as I can	0 for 'Disagree' 1 for 'Unsure' 2 for 'Agree'
2. Survey Q8: I often share my ideas in science lessons	0 for 'Disagree' 1 for 'Unsure' 2 for 'Agree'
3. Survey Q9: I like science	0 for 'Disagree' 1 for 'Unsure' 2 for 'Agree'
4. Survey Q11: I am good at science	0 for 'Disagree' 1 for 'Unsure' 2 for 'Agree'
5. Survey Q18: One of the grown-ups at home really likes science	0 for 'Disagree' 1 for 'Unsure' 2 for 'Agree'
6. Survey Q19: Someone at home tells me science is important	0 for 'Never' 1 for 'Once or twice a year' 2 for 'Every month' 3 for 'Every week'
7. Survey Q20: I tell someone at home about what I learnt in science in school	0 for 'Never' 1 for 'Once or twice a year' 2 for 'Every month' 3 for 'Every week'
8. Survey Q21: I draw or write about science	0 for 'Never' 1 for 'Once or twice a year' 2 for 'Every month' 3 for 'Every week'
9. Survey Q23: I think about science in my spare time	0 for 'Never' 1 for 'Once or twice a year' 2 for 'Every month' 3 for 'Every week'
10. Survey Q28: I look up science things on the internet	0 for 'Never' 1 for 'Once or twice a year' 2 for 'Every month' 3 for 'Every week'
11. Survey Q31 & 32: Does anyone in your family have a job that involves science? If yes, who in your family has a job that involves science?	If yes, 1 for each tick in Q32 0 for 'No' to Q31

Appendix C:
Teacher reflection sheets

Year group/class: ______________________________

Lesson topic ______________________________

Overall feeling ☺ 😐 ☹

What went well? (How/why/for whom?)

____

____

____

Challenges?

____

____

____

Even better if (ideas for next time)

____

____

____

____

____

Appendix D:

Glossary of terms

- **Key Stage (KS):** Key Stage is a term used in England to signify the stages of the schooling system. During the primary schooling years, there are two Key Stages: Key Stage 1 (KS1) includes Year 1 and Year 2, and Key Stage 2 (KS2) includes Year 3, 4, 5 and 6. Year 1 to Year 6 covers the age groups 5-6 to 10-11.
- **Cascading:** In this handbook, cascading refers to the dissemination of the approach from a single teacher's practice into whole school implementation. The cascading can be a slow and sustained effort – starting from sharing insights from your practice to others – to a more organised dissemination plan.
- **Buddy teacher:** To support with cascading and dissemination of the approach to the whole school, a teacher might choose to pair up with another colleague to refine each other's practice.
- **Ofsted:** Office for Standards in Education (Ofsted) is a body responsible for school inspections across English schools.
- **Science lead:** In England, primary schools often have designated subject leaders who are responsible for supporting all science-related decisions and encouraging good science teaching practice.
- **Equity:** The provision of resources according to need, ensuring that everyone has what they require to succeed. Aiming for equity is part of a process of actively moving everyone closer to success by 'levelling the playing field'.
- **Gender:** A socially constructed range of characteristics pertaining to, differentiating between, and stretching beyond, masculinity and femininity.
- **Social inequality racism:** Refers specifically to the ways in which institutional policies and practices create different outcomes for different social (racial, gendered etc) groups. Institutional policies may not mention any social group, but their effect is to create oppression and disadvantage for people from these groups.
- **Stereotypes:** Attitudes, beliefs, feelings and assumptions about a target group that are widespread and socially sanctioned. Stereotypes support the maintenance of institutionalised oppression by seemingly validating misinformation or beliefs.
- **Social privilege:** The unquestioned and unearned set of advantages, entitlements, benefits and choices bestowed on people solely because of their social background (eg: whiteness).

This glossary has been informed by a larger list created by the Making Spaces Project. The Making Spaces Project is a sibling project aimed at bringing transformative justice within and beyond makerspaces for youth science engagement. Find out more at https://m4kingspaces.org/

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Appendix F:
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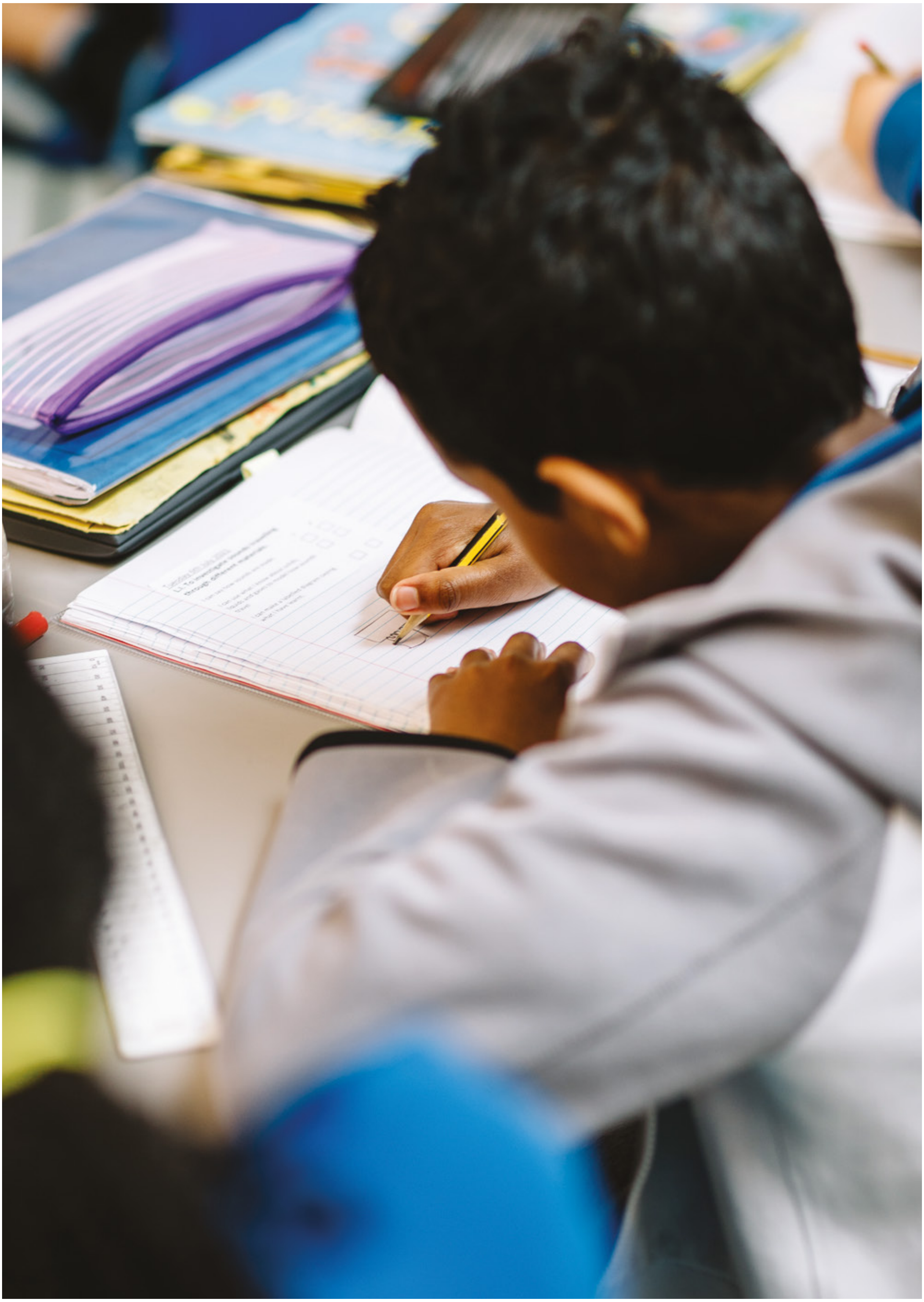

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Further information:

This resource is also available on our website:
www.ucl.ac.uk/ioe/PrimarySciCap

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