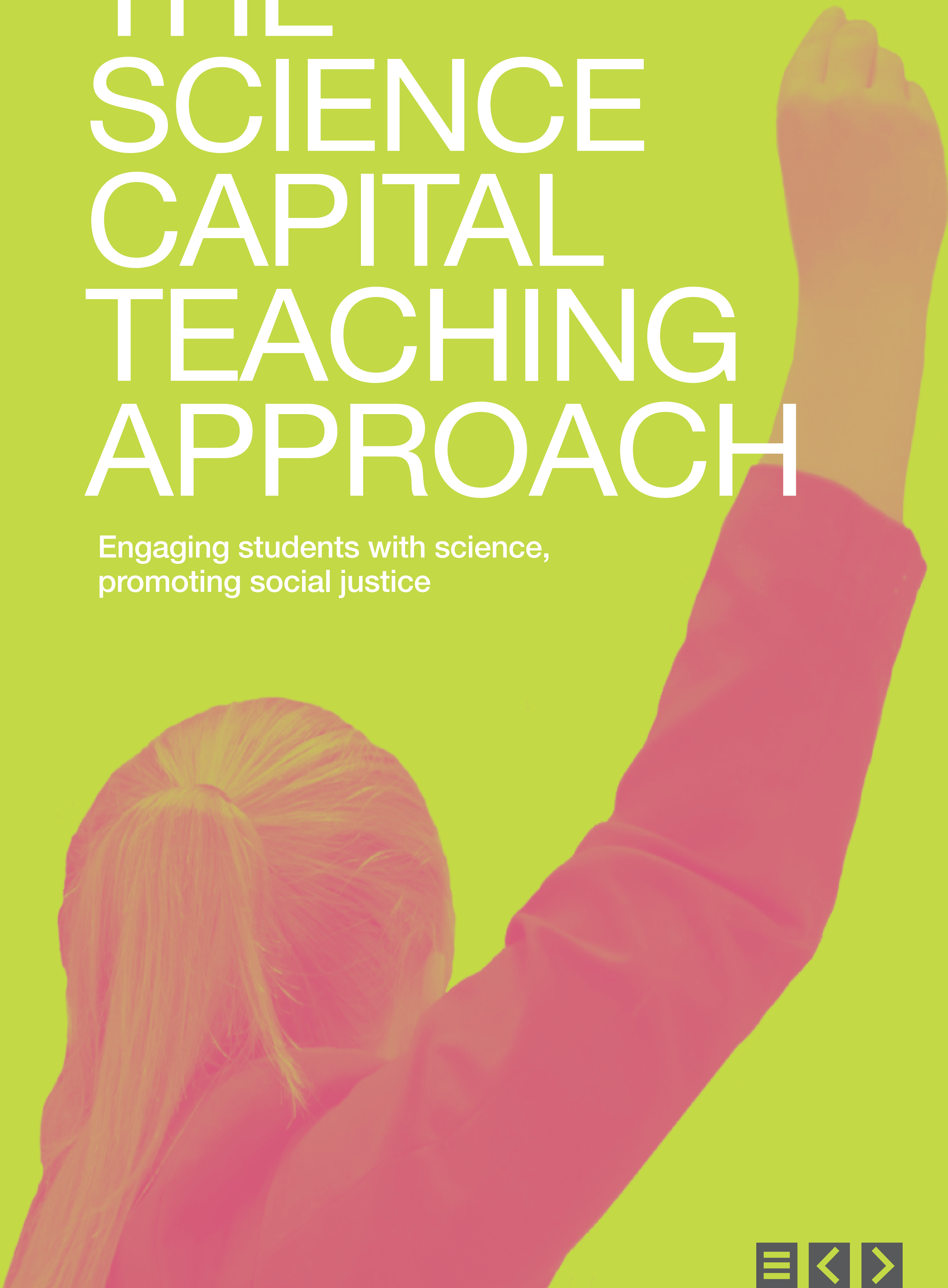
THE SCIENCE CAPITAL TEACHING APPROACH

Engaging students with science, promoting social justice



Some students struggle to see science as being relevant to their lives and as something that is for them. This can make their engagement with science difficult.

This pack will support teachers in helping students find more meaning and relevance in science and, as a result, engage more with the subject.

Why a social justice approach?

In the UK and many other countries there are long-standing patterns regarding who continues with science post-16. In the physical sciences—and engineering in particular—women, working-class and some ethnic groups are notably under-represented.[1] There are many reasons for increasing and broadening participation in science. For governments, a key issue is the importance of science, technology, engineering and mathematics (STEM) to national economic competitiveness, especially given a predicted future skills shortage. Our interest in improving student engagement and participation in science is driven by a social justice rationale, founded on the belief that:

- It is important to address social inequalities;
- Science can provide a route to social mobility, so more efforts should be made to include under-represented communities;
- Scientific advances mean that people will need to be increasingly STEM-literate if they are to be active citizens who can have a say in society.

A social justice approach focuses on improving science engagement and participation for both the personal and the public good.

The ideas presented in this pack have been co-developed and trialled over four years by 43 science teachers in a diverse range of secondary schools in England with both key stage 3 and 4 classes.

[1] WISE, 2012; Smith, 2011

Contents

What I’ve noticed is when I use the approach, I can see it in their eyes...like meerkats, they pop up and you can see the engagement.

Teacher

1. INTRODUCTION

The science capital teaching approach in a nutshell

To help more—and more diverse—students engage with science, the science capital teaching approach builds on good teaching practice. Its key distinction is an explicit focus on recognising and valuing students' existing science capital, whilst also helping them to build new science capital.

The approach works within any science curriculum. It is not a new set of materials and it does not mean a dilution of science ideas and concepts. Instead, it is a reflective framework that involves making small tweaks to existing practice so as to re-orientate science lessons in ways that can better connect with the reality of students' lives and experiences.

The concept of **science capital** is a way of encapsulating all the science-related knowledge, attitudes, experiences and social contacts that an individual may have.

How to use this pack

This pack provides a detailed manual for any teacher or educator who is interested in adopting the science capital teaching approach. It can be used as:

- A professional development resource for secondary science departments, and schools more widely, to address and increase social justice and engagement in science teaching.
- A resource for Initial Teacher Education to help student teachers reflect on social justice issues in the science classroom.

Section 2 introduces the idea of science capital and explores some of the reasons why student engagement with science varies.

Section 3 presents the foundation and the three pillars of the science capital teaching approach, with illustrative examples and exercises.

Sections 4 and 5 contain additional resources.

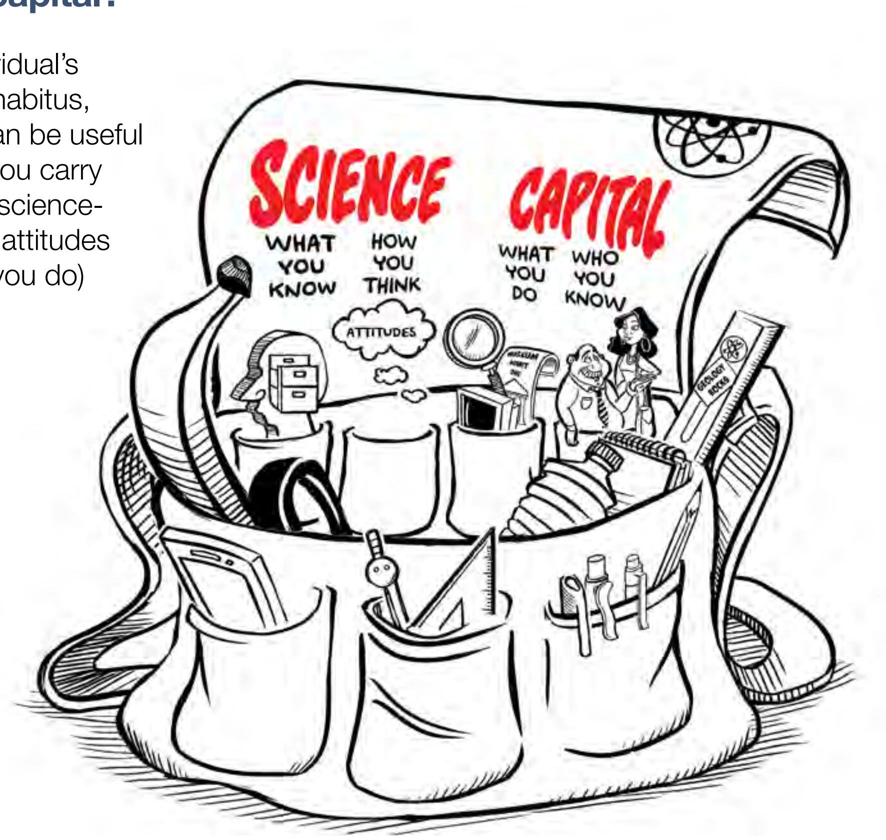
I think it's quite cool, because you think about it: 'Oh yeah, that's related to my everyday life' and you're, like, 'I'll remember that now'.

Student

2. UNDERSTANDING THE IDEAS

What is meant by science capital?

Science capital incorporates an individual's science-related resources and their habitus, or attitudes and way of thinking. It can be useful to think of science capital as a bag you carry throughout life that contains all your science-related knowledge (what you know), attitudes (what you think), experiences (what you do) and contacts (who you know).[2]



The concept of science capital draws on the work of sociologist Pierre Bourdieu (1977, 1984, 1986, 1990) and his theories of capital, habitus and field.

Capital describes the social, cultural and economic resources that an individual may have and is able to use to 'get on' in life.

Habitus refers to attitudes, dispositions and ways of thinking that are acquired through social experiences at home, in the community and at school. Habitus gives an individual a feel for the world, such as what is considered to be possible, desirable and thinkable.

Habitus and capital only exist and make sense within a particular field.

Field encompasses not just the physical setting but also the range of social relations, expectations and opportunities in a given environment. Field plays a key role because it determines whether or not an individual's resources and ways of thinking are valued.

[2] Archer et al., 2015; Archer et al., 2016a; Dewitt, Archer, & Mau, 2016

Eight dimensions of science capital

A student's science capital can be grouped into eight dimensions:

1. **Scientific literacy:** a student's knowledge and understanding about science and how science works. This also includes their confidence in feeling that they know about science.
2. **Science-related attitudes, values and dispositions:** the extent to which a student sees science as relevant to their everyday life.
3. **Knowledge about the transferability of science:** understanding the utility and broad application of scientific skills, knowledge and qualifications.
4. **Science media consumption:** the extent to which a student engages with science-related media including television, books, magazines and internet content.
5. **Participation in out-of-school science learning contexts:** how often a student participates in informal science learning contexts, such as at science museums, science clubs and fairs.
6. **Family science skills, knowledge and qualifications:** the extent to which a student's family have science-related skills, qualifications, jobs and interests.
7. **Knowing people in science-related roles:** the people a student knows (in a meaningful way) among their wider family, friends, peers and community circles who work in science-related roles.
8. **Talking about science in everyday life:** how often a student talks about science with key people in their lives (e.g., friends, siblings, parents, neighbours, community members).

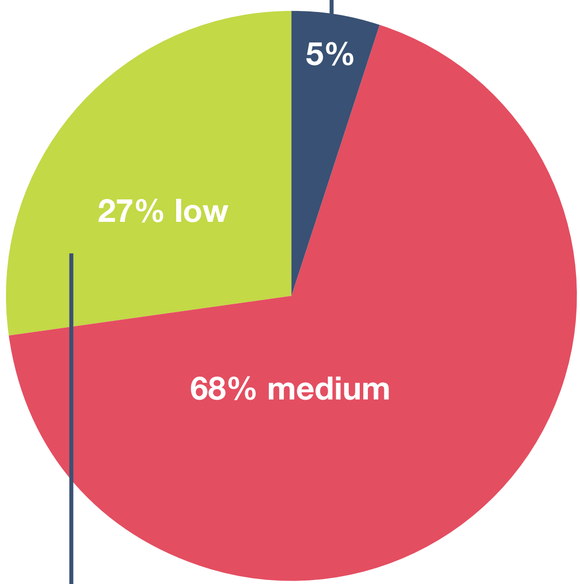
Science capital can help explain science engagement and participation

The concept of science capital was first developed within the ASPIRES project, a ten-year longitudinal study of young people's science and career aspirations (between the ages 10-18).[3] **A national survey[4] of 3,658 young people aged between 11 and 15 found that 5% had high levels of science capital, 68% had medium levels and 27% low levels of science capital.**

The more science capital young people have, the more likely they are to aspire to studying science in the future. They are also more likely to agree that other people consider them to be 'sciencey'.

Young people who have low levels of science capital tend not to see themselves as 'sciencey' and are less likely to aspire to studying science in the future. Those who do not see science as meaningful and relevant to them find it more difficult to engage with the subject.[5]

5% of young people have high levels of science capital



27% of young people have low levels of science capital

[3] ASPIRES 2 website; Archer et al., 2013; Archer & DeWitt, 2017
[4] Archer et al., 2015
[5] Archer, in press; Archer et al., 2017a; Calabrese Barton et al., 2012; Carlone, Scott & Lowder, 2014

Some forms of science capital are recognised more than others

Teachers can make a difference to student engagement with science by recognising and valuing students' existing science capital.

Some students have science-related hobbies that are not recognised by others and are not translated for use in the science classroom. This limits their opportunity to engage with science.

Alfie, age 12

Alfie is a year 8 student. He aspires to becoming a DJ or a music producer, and is not interested in continuing with education post-16.

At school, Alfie is in a bottom set science class and his teacher regards him as disengaged with science. Alfie thinks that science is 'not his thing' and says he does not know anyone who works in a job that uses science and never participates in anything science-related himself.

Alfie's dad runs a small events company and Alfie often joins him at the weekends. Alfie is responsible for installing the mobile disco equipment and ensuring that the circuits are set up correctly and that fuses are not overloaded.

Alfie's extensive knowledge and skills go unrecognised in his science lessons. He has few opportunities to share his capital and no connection is made between his practical understanding of technical equipment and the content of science lessons.

By implementing the science capital teaching approach, teachers have been able to improve the way they 'leverage' students' experiences, skills and interests to support and enhance their science engagement.

Sabiya, age 13

Sabiya is a year 9 student. She is not sure what she wants to be when she grows up and this is not something she ever talks about at home. She lives with her dad, her grandma, her older brother and two little sisters. She helps at home by taking care of her sisters after school, cooking and cleaning. She also assists with her grandma's vegetable garden; they grow a variety of herbs and vegetables. While gardening, her grandma tells stories about the farm she grew up on in Turkey.

Because of these stories and her work in the garden, Sabiya knows a lot about nature, especially plants and animals. She loves being outside and can name most of the plants in the garden and in the local park in both English and in Turkish.

Sabiya's science teacher recently found out about her interest in plants during a biology lesson and has begun to draw out Sabiya's knowledge for the benefit of the whole class. For the first time, Sabiya really feels like she has something to contribute in her science class.

Student engagement with science – why does it vary?

Student engagement is shaped by what students bring with them (their interests, dispositions, past experiences) and what is expected, supported and valued within the science classroom.

For some students, school science will feel very familiar and comfortable, whereas for others it will feel distant and even alienating.

Research evidence shows that the science capital teaching approach is an effective way to improve student engagement with science by helping all students to feel comfortable and valued in the science class.[6]

The burning flame of student engagement with science

The analogy of a burning candle can be used to think about student engagement with science and the role of the social context. Although the analogy is not completely scientific, it helps to illustrate the complexity of student engagement.

- The flame represents a student's engagement with science. How well it burns and whether it flickers or is constant will vary across contexts and time.
- The candle represents a student's attitudes, dispositions and capital.
- The heat to spark the flame can be brought by a teacher or a science encounter.

- Crucially, it is the air, the conditions and the environment surrounding the candle that determine whether the flame stays lit and how brightly it burns. For a real candle, this would include whether there is sufficient oxygen or too strong a wind. In this analogy, it is the range of expectations and opportunities that are available to a student, and whether or not a student's resources and ways of thinking are valued.

For students whose resources, experiences and dispositions are valued and supported within the science classroom, the flame of engagement will burn brightly and consistently.

Those whose resources, experiences and dispositions are not valued may not feel a connection with the lesson and, consequently, the flame of engagement may struggle to burn.

[6] Archer et al., 2017b

A strong or a weak flame? Student engagement with science

Joshua, age 11

About Joshua's mum works as a laboratory technician and his dad is an engineer. They have high aspirations for Joshua to study at university and get a good job. Joshua thinks science is important for everyday life and hopes to become an inventor. He regularly reads science books and watches science-related videos on YouTube, and the family often visit museums during the weekends and holidays. Therefore, Joshua has high science capital.

In science lessons Joshua is confident and loudly displays his knowledge of science. This gets Joshua noticed by his science teachers and peers, who agree that Joshua is 'sciencey' and will most probably pursue science in the future. His contributions are explicitly valued by his teachers, which positively reinforces his sense that science is for him.

Joshua's engagement with science
Joshua possesses the 'right' resources and behaves in line with his teachers' expectations. The field of school science celebrates active and visible participation. It is not only Joshua's knowledge and behaviour *per se* that afford his success, but the alignment of such knowledge and attitudes with the expectations of the classroom. His engagement flame burns easily in science lessons.

Tracey, age 12

About Tracey's mum works as a cleaner and her dad is a car mechanic. No one from her immediate or extended family has ever attended university and Tracey remarks that her mum often warns her that university could be a difficult experience. Tracey hopes to become a celebrity, although she also talks about maybe working with animals, perhaps as a veterinary nurse. When asked about her knowledge of animals and animal health, she says that this does not count as science. Despite some science interest, Tracey's science capital score is relatively low.

In science lessons Tracey rarely answers her teacher's questions. She tends to sit at the back of the classroom and chats to a group of her friends, resulting in being reprimanded for disruptive behaviour. When she occasionally tries to contribute to discussions, she is often teased by her classmates for using incorrect terminology. The accumulation of these experiences has led Tracey to think that science is not for her. She plans to drop science as soon as she can.

Tracey's engagement with science
Tracey's candle offers little fuel to burn in the context of school science. Her knowledge and interests are not elicited or recognised in her science lessons and her classroom participation does not fit with classroom expectations. The field does not enable Tracey to draw on her resources and her attempts to participate are often rejected. Her engagement flame is barely alight and is at risk of dying out.

Outcomes of the science capital teaching approach

Adopting the science capital teaching approach has resulted in substantial benefits for both students and teachers.[7]

Benefits of the science capital teaching approach for students

Evidence shows that the science capital teaching approach:

- Improves students' understanding and recall of science content.
- Helps students find science more personally relevant.
- Deepens students' appreciation of science.
- Widens and increases students' engagement with science in lessons.
- Improves students' behaviour during science lessons.
- Increases the proportion of students seeing themselves as 'sciencey'.

> *"More students get more work done and there's less disruption. There's more interest."*
> ***Teacher***

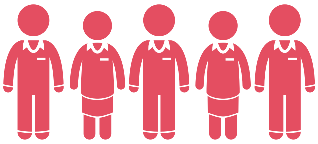
> *"I think it's quite cool, because you think about it: 'Oh yeah, that's related to my everyday life' and you're, like, 'I'll remember that now'."*
> ***Student***

> *"Having pupils who not only get on, but also contribute, is fulfilling to me as a teacher."*
> ***Teacher***

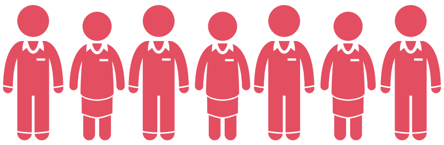
> *"I think it's more interesting because you have an idea of where science might come up in your daily life."*
> ***Student***

[7] Benefits were reported by teachers and students through interviews and discussion groups, and were evidenced by student surveys, classroom observations and a range of additional measures, such as behaviour and attainment data collected by participating teachers. See King et al., 2015; Archer et al., 2017b, King & Nomikou 2017.

The science I learn in lessons is related to my everyday life (outside of school).

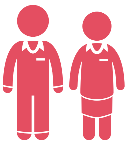


Beginning of the year - 26.2%

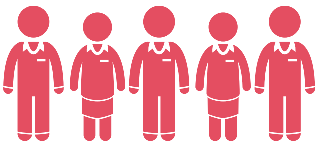


End of the year - 35.8%

My science teacher knows me well.



Beginning of the year - 11.9%



End of the year - 27.0%

Benefits of the science capital teaching approach for teachers

In addition to the benefits of teaching more engaged students, many teachers speak of positive changes to their own professional identities and sense of purpose as teachers. They believe that the approach has created opportunities to be reflective and challenge the *status quo*, and describe an increased sense of purpose and agency.

> *"You're not just bombarding them with information. You're drawing them in with things that they understand, that are relevant to them. That makes lessons a bit more interesting and more successful."*
> ***Teacher***

> *"Before joining the project, I was getting a little bit less creative with the lessons. I'd been sort of content to get things done. Doing science capital has allowed me to be creative again and change things in my lessons."*
> ***Teacher***

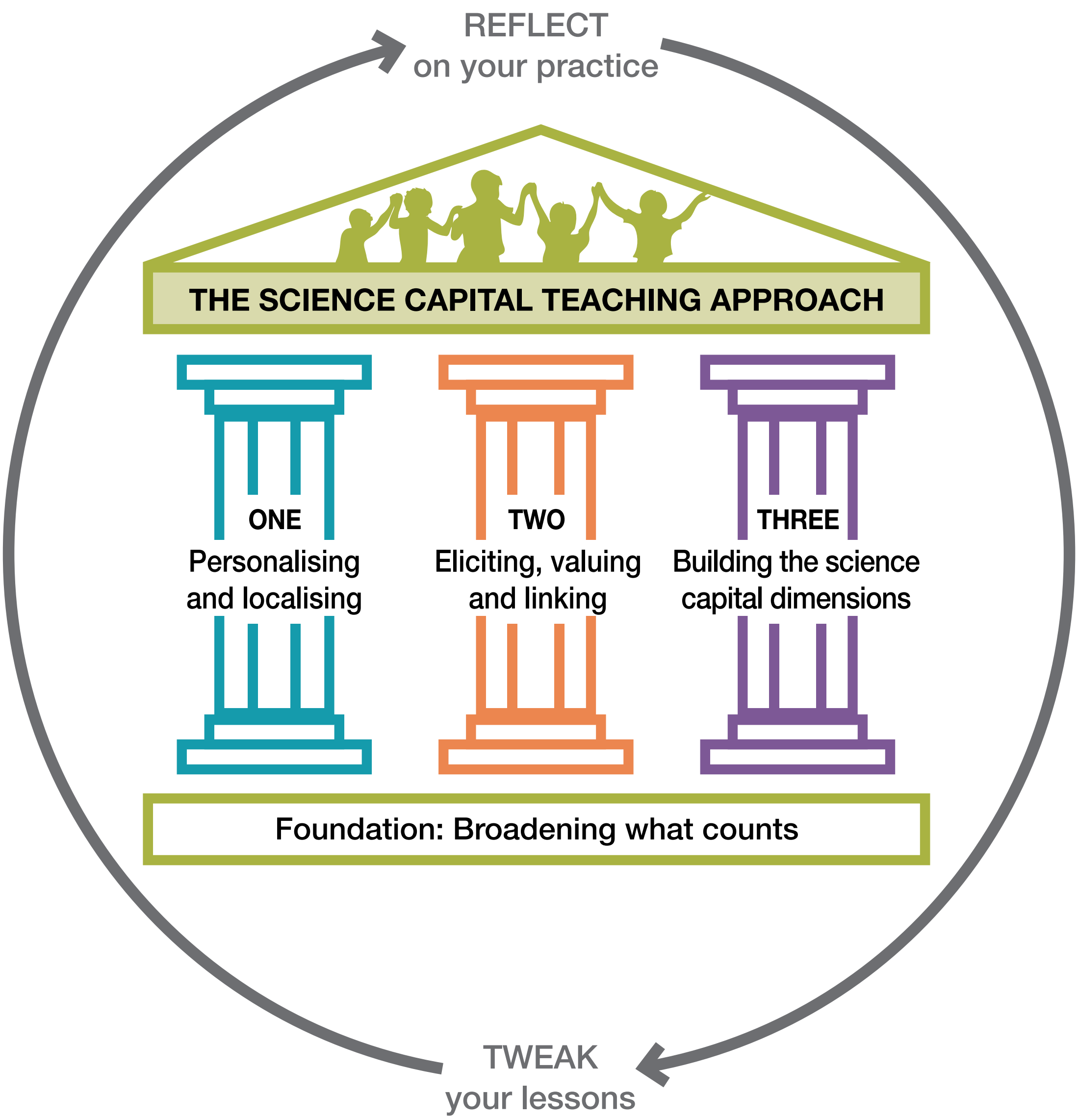
It brings everyone together. Everyone has something to say, instead of it just being one or two people that know the answer.

Student

3. THE SCIENCE CAPITAL TEACHING APPROACH

The science capital teaching approach is based on the foundation of ***broadening what counts*** and the three pillars: ***personalising and localising***, ***eliciting, valuing and linking*** and ***building the science capital dimensions.***

The challenge of how to engage all students is a long standing educational concern – not just in science, but across all subjects. However, the historical culture of science (for instance, popular views of scientists as white, male and middle-class) can mean that engagement issues are amplified. While this is an enduring challenge, evidence shows that individual science teachers can make a difference in their own classrooms.



I think there's more student engagement … especially by students who don't normally contribute in lessons.

Teacher

FOUNDATION:
Broadening what counts

When we think of the difficulties that students face, we tend to focus on how they might cope with difficult scientific concepts. But some students encounter barriers even before they start grappling with the content. They struggle to engage with science. They feel distant from science and do not see themselves as 'sciencey'. They feel unable to participate in class.

Broadening what counts involves creating spaces where all students feel able to offer contributions from their own experiences, interests and identities, knowing that they will be valued.

This foundational principle underpins what teachers do in practice. It is a mind-set that centres on recognising a broader range of experiences, skills and behaviours as having a legitimate place in the science classroom.

This principle acknowledges the importance of field: the ways in which the learning environment and expectations are constructed. Field determines how well students are able to 'get on' in the science classroom.

Teachers broaden what counts by:

- Establishing class ground rules where all student contributions are welcome and respected.
- Regularly reviewing student participation and ensuring that certain students do not dominate or prevent others from speaking.
- Creating opportunities for students to express themselves in ways they feel comfortable.
- Highlighting the scientific nature of different sorts of contributions.
- Talking about different types of people who work in science or science-related jobs, showcasing examples in wall displays.
- Helping to broaden students' views of what counts as doing science in the classroom – so that curiosity, questioning, sharing experiences and relating to science through personal experience are valued. It's not just about getting the right answer.
- Challenging the stereotype that science is only for certain sorts of students.
- Regularly discussing ways to encourage more students to participate with colleagues.

Broadening what counts in practice: snapshot from a science lesson

Ms Tang's class is often lively and she asks many open questions, some of which do not require previous science knowledge to answer.

When she asks a question, many students raise their hands. They are confident to 'have a go'. They do not fear getting the answer wrong. Nor do they fear disapproval from the teacher for an incorrect answer or being teased by their peers. In fact, Ms Tang regularly stresses that 'every contribution is welcome'.

Ms Tang has created a classroom environment where student contributions are welcomed and respected.

Ms Tang welcomes contributions from as many students as she can and notes their responses on the board for further discussion. **She makes sure that she returns to the students' contributions later in the lesson.**

Ms Tang tries to ensure that as many students as possible contribute and that no-one dominates.

In addition to welcoming comments, Ms Tang sometimes invites individuals to describe their experience and expertise in a particular area. At the beginning of the year, Ms Tang spent a couple of lessons finding out about her students' interests and backgrounds.

She knows, for instance, that Connor's dad is a mechanic and that Connor is keen to follow his father's footsteps. During a lesson on hydrocarbons **she regularly refers to the car industry and the role played by people like Connor's dad in monitoring emissions from engines.** She highlights how checking emissions contributes to looking after the environment by keeping cars efficient. **She invites Connor to share other insights gained from helping his dad in the garage.**

Ms Tang talks about people known to the class who work in science-related jobs.

Ms Tang highlights the scientific nature of students' contributions.

By making small changes to her lesson, such as having open questions, welcoming all responses and highlighting students' experiences, Ms Tang has created a welcoming and supportive atmosphere where students feel recognised and valued for their contributions.

Exercises

Reflecting on engagement in your science class

Think about one of your science classes:

- Are there any students in the class who may feel that science is not for them?
- Do you notice any patterns in terms of who participates—and how—during lessons?
  - Are there differences between boys' and girls' participation?
  - Are there differences between the participation of different ethnic groups?
- What does 'good' engagement look like in this class?
- Why might some students find it easier than others to participate, show their knowledge and connect with the subject matter? What stops others from doing so?
- Are there any students who you would like to see participating more? What have you tried to encourage them to do so?

Observing a lesson with a focus on students' participation and engagement

Ask a colleague to observe your lesson, paying particular attention to how students engage (or disengage) with science during the lesson. It would work best to do this with a class where student engagement with science is variable.

- Which students speak up most? Who is consistently quiet? Who seems disengaged?
- Are there different ways that students engage with science (through confident contributions, quiet and diligent work, discussing with their neighbour)?
- Are there any students who dominate the class? If so, how? What does this mean for other students?
- What factors seem to contribute to these patterns?

How might you facilitate engagement with science for these different groups of students in your class?

Thinking about the role of the science classroom

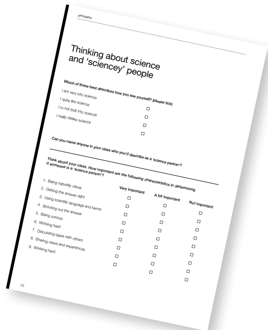
Read the excerpt below about Radha, an 11-year old student.

About Radha is interested in science and wants to be a doctor, a scientist, or a lawyer. Radha's mum used to work as a science teacher and several of her siblings and cousins are currently studying or working in science-related areas. Conversations about science are commonplace in her family. Due to her family members studying and working in science, along with her interested in the subject, Radha has a relatively high science capital score.

In science lessons Radha rarely says a word during her science lessons unless she is called upon by her teacher. She says that a group of loud boys in her class make it difficult for her to speak up. While she works diligently, Radha is not perceived to be 'sciencey' by her teachers or her peers. She rarely receives explicit recognition for being a good science student.

- How do you think Radha feels about science?
- Does the field of the science classroom work for Radha?
- How could Radha's teacher *broaden what counts* to allow Radha's science capital candle to burn more brightly?

Who do students think is 'sciencey'?


APPENDIX

Thinking about science and 'sciencey' people

Which of these best describes how you see yourself? (please tick)

I am very into science ☐
I quite like science ☐
I'm not that into science ☐
I really dislike science ☐

Can you name anyone in your class who you'd describe as a 'science person'?

Think about your class. How important are the following characteristics in determining if someone is a 'science person'?

	Very important	A bit important	Not important
1. Being naturally clever	☐	☐	☐
2. Getting the answer right	☐	☐	☐
3. Using scientific language and terms	☐	☐	☐
4. Shouting out the answer	☐	☐	☐
5. Being curious	☐	☐	☐
6. Working hard	☐	☐	☐
7. Discussing ideas with others	☐	☐	☐
8. Sharing views and experiences	☐	☐	☐
9. Working hard	☐	☐	☐

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This could be done through short questionnaire (see a photocopiable questionnaire in section 5).

Look for patterns in the answers:

- Are there clear patterns in how students see themselves, or who is named as a science person? For example, are there differences between boys and girls or between students of different ethnicities?
- What kinds of behaviours and characteristics do your students list as signs of being good at science?
- To what extent do students select statements 1-4 as important indicators of how 'sciencey' someone is? These characteristics are often cited by students, with fewer students mentioning statements 5-9. What would you say are the most important characteristics? How might you share your insights with your students?
- How might you help broaden students' views of what counts as being 'sciencey', so they are able to recognise other attributes (such as those in statements 5-9) as being important?

Is there anything you want to change in your own practice based on what you have learnt from this exercise?

If you repeat the questionnaire across different groups and over time, are the patterns the same or different?

Reading the research summary: Killing or encouraging curiosity?

Read the research summary of an academic paper: Killing curiosity? An analysis of celebrated identity performances among teachers and students in nine London secondary science classrooms.[8]

This summary presents research findings from a study of nine Greater London science teachers and their students. Researchers examined teachers' and students' views about student engagement in the science class.

Teachers articulated a common set of values, notably wanting students to be intellectually engaged (curious, problem-solvers); social and cooperative (engaging in discussions, sharing knowledge and ideas); and self-directed learners who are also creative. When asked what they thought their teacher valued in students, most students identified similar traits.

When students were asked who in their class was a 'science person', across all schools and age discussion groups without exception they identified peers who they perceived to be brainy and smart. As one Year 9 boy explained: 'you've just got to have general knowledge and, like, you've just got to be the one that always puts their hand up.' Interestingly, when asked who is a science person in their class, only one (predominately female) discussion group identified a girl.

The study identified three 'celebrated identity performances', or valued ways of behaving and participating in the class:

- muscular intellect
- behavioural compliance
- tick-box learning

Performances of muscular intellect involved 'talking science' in loud and confident ways, mostly by boys. As one boy explained, 'confidence is the key' for showing knowledge. These performances were in some cases problematic and exclusionary of other students who were unwilling or unable to act in these ways.

Behavioural compliance, including waiting to be asked to speak and not shouting out, was reinforced by both teachers and students. Good behaviour, however, tended to be at odds with the more active science performance of muscular intellect, and students who were well-behaved but did not actively participate, risked not being seen as 'scientific' by others.

Many students were also highly aware of the importance that schools place on exams. Across the board, teachers felt that high-stakes public examinations created a culture of instrumentalism, in which students resisted behaviours involving curiosity, and instead focused on what they need to pass examinations.

[8] Archer et al., 2017a

All three dominant identity performances entail potentially challenging consequences for science engagement. They close opportunities for different types of behaviour to develop and reinforce narrow views of who and what is seen as 'scientific'.

Discuss with colleagues, or reflect on the following:

- Do you agree with the identification of these three ways of performing in science? What categories of student behaviour and engagement have you identified in your classroom?
- Thinking of a particular class that you teach, can you identify students who fit each of the three 'celebrated identity performances' described in the summary?
- How might you help to broaden perceptions of what counts as being 'sciencey' in your classroom?

Don’t use a context that the kids couldn’t care less about - make it personal to them.

Teacher

PILLAR ONE:
Personalising and localising

Personalising and localising is about making science content personally relevant to the everyday lives of students. This approach goes beyond contextualising science – the key is to relate the content to examples and experiences from the students' own lives.

Personalising and localising helps students see that their interests, and attitudes and experiences at home and in the community relate to aspects of science. This helps them to realise that they have resources which are valued in science and enables the flame of engagement to burn more brightly.

Teachers personalise and localise by:

- Building on their knowledge of students' interests, aspirations, local communities and past experiences.
- Using examples and settings that are familiar and local to students as 'hooks' into the science content.

Evidence from research: Social constructivist theories

Why do students' backgrounds matter for learning and engaging with science? Social constructivist learning theories argue that learning is deeply embedded in who we are, how we are socialised and the different learning environments we encounter (Vygotsky, 1978). Students' backgrounds affect not only how they learn but also what they learn. Pioneering work on how children understand science showed that common misunderstandings and misconceptions about science often came from a mismatch between how children understood the world and the way science was taught in schools (Driver, 1989). It is important for teachers to understand the ideas that students bring with them into classrooms in order to teach most effectively.

Social constructivist pedagogy highlights the ways in which understanding accrues as we build on our previous experiences. The science capital approach builds on social constructivist pedagogy by using ideas from Bourdieu (1977, 1984, 1986, 1990) to help teachers think about what students bring into the classroom in terms of pre-existing knowledge, interests, ways of thinking and their socio-cultural backgrounds, families and friends.

Personalising and localising in practice: snapshots from science lessons

Example One

In a revision lesson, Ms Amos sets the following scene: **'Imagine you are practising for the school production at the weekend so the canteen is closed.** You're really hungry. You want to buy some food, but only have a short time before you have to be back in the hall. Which takeaway do you think you could get to, from school, in 15 minutes?'

Ms Amos sets out an example that students are likely to be personally familiar with.

She shares images of familiar and popular local takeaways on screen and their relative distance from school.

Ms Amos does not use abstract examples but instead uses real, local places and an issue that she knows will resonate with her class.

(She is aware which takeaways the students frequent from a previous lesson earlier in the term on nutrition when they discussed their favourite food types and restaurants.)

Ms Amos says 'How are we going to use science to work this out? We know the distances. You've got 15 minutes before you are supposed to be back. Can you get there and back in that time?'

With some prompting from Ms Amos, the students recall the speed/distance/time triangle.

Next, Ms Amos asks: **'Do you know how fast you are? How fast can you walk and how fast can you run?'**

Ms Amos asks about students' personal experiences.

The students start teasing each other as to who is fitter and who is faster. Jack says he could get to his favourite chippy in five minutes. Ms Amos asks: **'How could you measure your speed? Think about any experiences you have had that would help you to work this out.'**

Ms Amos encourages students to think about their own experiences and how these might relate to what they are doing in the lesson.

Students discuss on their tables. Jenny mentions that in a recent Physical Education class their sprint times over 100m were timed by the sports teacher. She remembers her time and suggests that they calculate the speed from there.

After this starter (taking approximately 10 minutes), the lesson continues with the students committed to solving a variety of speed, distance and time problems. Ms Amos finishes the lesson by asking students to think about how they might use this knowledge in their lives outside of school. Reese, a keen army cadet, talks about the importance of making such calculations when planning routes and practicing manoeuvres.

Personalising and localising in practice: snapshots from science lessons

Example Two

Mr Michaels previously set homework requiring students to think about energy efficiency in their home, and to ask their adults how expensive the heating is compared to other bills.

Mr Michaels roots the lesson in an issue which will be important in every household.

In the lesson which follows, he asks students about what they found. Shelly says: 'I live in a house where there is nothing on the other side, which means its colder'. **Mr Michaels agrees and asks who lives in an end of terrace house, in the middle of a terrace, or in a flat (surrounded by other flats).**

Mr Michaels relates the issue to students' own lives, such as the types of houses they live in.

Mr Michaels shows a slide with heat transfer/loss through doors, windows and walls and asks 'What could we do to reduce the heat loss? **Could you tell me of any examples of what your parents or someone you know has done to reduce the heat loss where you or they live?'** Students discuss in small groups and record their answers on mini white boards before reporting back to the whole class.

Mr Michaels asks students about experiences from home.

Esme's group has recorded double glazing and she tells the class about how and why her home has recently been double-glazed.

Natasha comments 'I live in quite an old house, it even has a fireplace that's not bricked up or anything'. They discuss how older homes may be less efficient than more modern ones.

Kiara's aunt is a builder. She says that for all new buildings, there are laws in place requiring builders to include energy-efficient measures.

Mr Michaels then encourages the class to consider the cost of double glazing or loft insulation against the money saved on heating bills. **He shares details of the school's heating bill,** and the class are shocked by the expense and keen to find out more. The emphasis on their own school has really piqued their interest and all appear eager to share their opinions—largely informed by science—on what steps could be taken.

Mr Michaels refers to a personal and local interest: the expenditure in their school.

Mr Michaels asks the class if they would like to invite the School Premises Manager into a lesson to discuss ways of reducing the bill. The students agree with this suggestion and look forward to the discussion.

Exercises

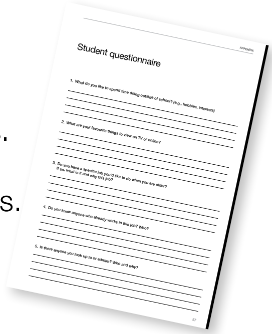
Finding out about your students' lives outside of school

What do you already know about students' outside school lives and interests? Spending time early in the year to get to know your students' interests, backgrounds and cultural references can help with personalising and localising in subsequent lessons.

> *Knowing a little bit more about my students' backgrounds has put me in a better position to be able to plan my lessons. It's helped me plan ahead – I can pre-empt what sort of conversations and questions may come up.*
>
> ***Teacher***

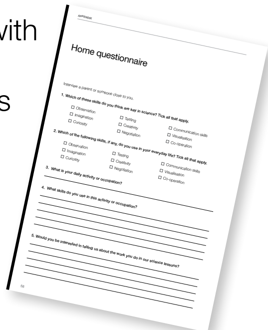
> *Finding out about my students has really helped me to engage them better. If they see that I am interested in them, they are more likely to want to take part. They see I care.*
>
> ***Teacher***

Student questionnaire
Some teachers have found it useful to carry out a short questionnaire as a way to find out more about their students. Questions included hobbies, interests and future aspirations. What else would you want to include?


Student questionnaire

See a photocopiable Student questionnaire in section 5.

Home questionnaire
One of the teachers worked with students to design a 'Home questionnaire', which students took home and gave to their parents, older siblings and other people in their lives.


Home questionnaire

See a photocopiable Home questionnaire in section 5.

Getting to know the local area

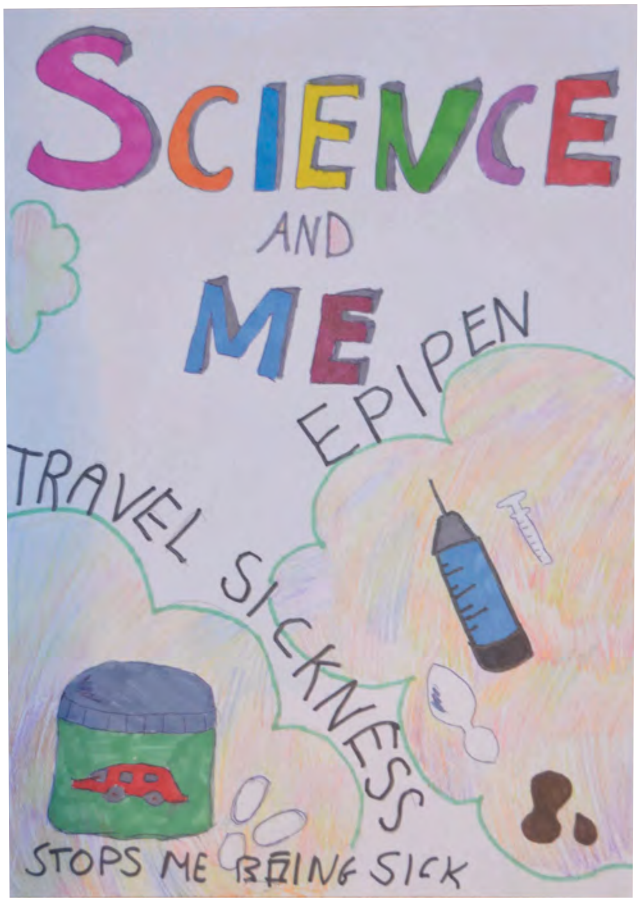
In case not already familiar, try to find out more about the local area around the school.

> *I didn't know much about the local area – I would drive in and out and didn't know the town well at all. One day I walked the same way home as the kids. I really saw the environment that they experience every day.*
>
> ***Teacher***

Science in students' everyday lives

To better understand students' everyday realities and experiences:

- Ask students to write down (or take photos of) anything that might relate to science that they encounter from the time they get up to when they get to school. Use this information and/or material in subsequent lessons.
- Ask students to design a poster answering the question 'What has science done for me?'



When a child's worldview is left unvalued and expressionless in an educational setting, what should we expect in terms engagement, investment and learning from that child?

Professor Angela Calabrese Barton

PILLAR TWO:
Eliciting, valuing and linking

Asking questions to ascertain prior knowledge and check understanding is the bread and butter of a teacher's practice.

The focus of the second pillar of the science capital teaching approach is to use questions to elicit students' knowledge that draws on personal, family and/or cultural experiences. Valuing refers to explicitly recognising and acknowledging the contributions to emphasise that such knowledge is relevant and worth sharing. Linking is about connecting students' contributions and experiences to appropriate aspects of curriculum science.

Eliciting, valuing and linking supports students in feeling that their ideas and experiences are valid in the context of science. It helps students feel more able to contribute and participate in the science classroom. In this way, more students feel that science can be for them.

Teachers elicit, value and link by:

- Inviting students to think about and share their own experiences or ways of understanding.
- Regularly using open questions.
- Sharing relevant examples from their own personal life experiences to help create an environment where all sorts of contributions are valid.
- Finding ways of including quiet or shy students, such as allowing them to work in pairs or small groups prior to talking in front of the whole class, or accepting written contributions.
- Being prepared to follow up on a student comment or question. Comments can be indicative of a student's personal interest, and may also be of relevance to others in the class.

Evidence from research: Funds of knowledge

The term funds of knowledge refers to the various sources of cultural and everyday knowledge, skills and resources that members of some social groups may possess, which could be quite different to the knowledge that is usually required and valued in science classrooms (Zipin, 2009; Moll et al., 1992). For instance, families may be very skilled in agriculture, household management, cooking and so on, but these forms of expertise may not necessarily be recognised within the school curriculum and may remain hidden and untapped pools of potential expertise.

Recognising students' varied skills and experiences has been found to provide a good basis for social justice approaches to education (Basu, Calabrese Barton & Tan, 2011). When students are able to learn in ways that value and respect their interests, knowledge and cultural backgrounds, they engage more fully and feel more empowered to contribute in lessons.

Eliciting, valuing and linking in practice: snapshots from science lessons

Example One

Mr Lloyd asks the students 'Why do we need protein?'

Students discuss in small groups and come up with 'to get strong', 'for growing', 'to build big muscles' 'to stay fit'. He writes the answers on the whiteboard.

Julian suddenly asks: 'Is insulin a protein?'

Julian is usually noisy in class, and rarely on task. Mr Lloyd recognises that behind this question is a knowledge of insulin and potentially the treatment of diabetes. **He asks Julian to say what he knows about insulin and what it is used for.**

Mr Lloyd acknowledges that Julian might have some knowledge from outside school and elicits his contribution.

Julian says: 'My grandma has diabetes. She has to inject herself in the tummy with insulin'

Mr Lloyd asks Julian: **'Do you know what the insulin does? Why does your grandma have to inject it?'**

Mr Lloyd elicits further. In this way, he values Julian's knowledge of diabetes and insulin.

Julian replies with apparent pride that he knows the answer: 'It sorts out her blood sugars. Most of us do it, like, naturally. But some people don't have insulin, or they have too much, so something like that.'

Mr Lloyd says: **'Thank you Julian, that was really interesting.** Yes, our bodies make insulin and it's a protein that regulates how much sugar we have in our blood. Too much, or too little, is dangerous. If a diabetic has the incorrect amount they could collapse.'

In welcoming Julian's comments and thanking him for his contribution, Mr Lloyd is valuing his contribution. In addition, he links further science content to Julian's comment.

The rest of the lesson is about the nature of proteins and the role they play in our bodies. Mr Lloyd regularly refers back to insulin reminding students about **'the example that Julian gave us earlier'.**

By referring back to Julian's contribution, Mr Lloyd continues to value it.

Eliciting, valuing and linking in practice: snapshots from science lessons

Example Two

To start the lesson, Ms Atkinson shows the class a picture of a surveyor using a theodolite. She asks the students to put their hand up if they have seen someone using a tool like this before.

Ms Atkinson notes that Jonah, who rarely says anything in class, has his hand up. She asks him: 'Where have you seen it?'

Ms Atkinson elicits students' experiences outside of the science lesson.

Jonah replies: 'I've seen the guys who work with my dad use them.'

Ms Atkinson asks further questions about Jonah's father's job.

Ms Atkinson elicits further information about Jonah's knowledge of his father's job.

Jonah explains that his father is a construction manager. He says that he thinks the tool in the picture is used to see if the ground is level before building begins.

Ms Atkinson thanks Jonah for his explanation and for sharing his knowledge.

Ms Atkinson values Jonah's contribution by thanking him.

She then asks if anyone else has a parent or relative or knows someone who works on a building site. Several students raise their hands and a few students share stories about these people and what building work they were involved with in the past. **Ms Atkinson then uses these students' knowledge of the building trade to talk about the different sorts of materials—concrete, steel, wood and glass—commonly used** and, thereafter leads a class discussion about their various properties and uses.

Ms Atkinson elicits further contributions from students.

Ms Atkinson links students' contributions to science (the properties of different materials).

Wherever possible, she refers to students' prior contributions, regularly referring, for example, to 'Jonah's dad and his knowledge as a builder'.

Ms Atkinson continues to value student contributions and make explicit links to the curriculum.

Exercises

Questions to elicit students' existing knowledge and experiences

To help elicit students' existing knowledge and experiences, some teachers have found it helpful to use question stems. These can be useful for asking open questions that do not have a single right answer. For example:

- Who needs to know about …? (relating a topic to careers, hobbies and daily activities)
- Can anyone tell me about a TV programme they have seen that involved …?
- Does anyone know someone who uses this skill/knowledge in their daily lives?
- Does anyone's family member work in a job where they need to know about …?
- Where have you seen something a bit like this before…?
- From your knowledge outside of school, how would you describe …?

Think about a topic that you are teaching soon. Looking at the suggested question stems above, what questions could you ask your students to elicit their outside of school knowledge and experiences? How could you value their responses and link them to the curriculum?

Possible questions for a lesson on proteins and nutrition:

- Who needs to know about nutrition and eating well?
- Can anyone tell me about a TV programme they have seen on nutrition/dieting/eating healthy? What did it say?
- Does anyone's family member work in a job where they need to know about nutrition or use the knowledge in their daily lives? What do they do? What knowledge do they need?
- Do you talk about healthy eating at home? What do your parents/family/carers say about this?

> *"Eliciting involves broad, open questioning, which is also personal. It's asking students about their own experiences, rather than things in general."*
>
> ***Teacher***

Valuing students' contributions

Students' contributions can be valued on different levels. One way to think about it is to distinguish between 'thin' (brief, surface-level) and 'thick' (extended, substantial) valuing.

Thin valuing (less effective) involves short instances of praise such as 'Good', 'Well done', 'Yes, correct. Right, next question is …'

Thick valuing (more effective) involves more substantial acknowledgement and recognition of students' contributions, such as:

- Writing students' contributions on the board and returning to them later in the lesson or during a future lesson.
- Asking students to repeat what they said in front of the class.

Think about some examples of thin and thick valuing across recent lessons. Is there a pattern? Do you tend to value certain students or types of contributions more? What could you do to change this pattern?

Planning ahead

Effective eliciting, valuing and linking is a skill that requires practice and forward planning.

Consider a topic or lesson you will be teaching soon that students have usually found to be dull or dry. Use reflective questions below to plan the lesson.

- What type of questions can you use to help elicit students' personal knowledge and experiences about the topic?
- What personal story or anecdote could you tell about the topic to prompt contributions from the students?
- Thinking about possible contributions that the students may make, how might you connect these to the curriculum?

I get students to talk to parents at home about what we learn.

Teacher

PILLAR THREE: Building the science capital dimensions

To help students add more to their science capital 'bags', teachers can address the eight science capital dimensions across and throughout their lessons.

The list below suggests some of the possible ways different dimensions of science capital can be incorporated into science teaching. Which of these tactics could you use in your own teaching?

Teachers build the science capital dimensions by:

1 **Scientific literacy**	■ Supporting students' understanding of science and how science works.
2 **Science-related attitudes, values and dispositions**	■ Discussing the value of scientific developments and the role science plays in culture, society, and the local community. ■ Talking about the use and misuse of scientific evidence in everyday life – from marketing claims to climate change. ■ Broadening the idea that a diverse range of people use science skills and applications—for example, inquiry skills, creativity and analytical skills—in all sorts of everyday activity.
3 **Knowledge about the transferability of science**	■ Highlighting science skills involved in the varied jobs to which students may aspire. For example, framing analytical skills as useful in business, law, and journalism, as well as in everyday life, such as when making financial decisions.
4 **Science media consumption**	■ Encouraging students to watch science documentaries on TV or online, or read science-related news. These could be discussed and drawn upon during science lessons.
5 **Participation in out-of-school science learning contexts**	■ Pointing students to local (free if possible) science learning opportunities; arranging a school visit; asking students about out of school activities and places where they encounter science. ■ Maintaining an up-to-date 'what's on' calendar, where students can also list activities. ■ Asking students about their tinkering, repairing, crafting or artistic habits at home. Linking these with lesson content where applicable.

6 **Family science skills, knowledge and qualifications**	■ Supporting students to find and recognise any science skills and knowledge that their family members might use in their jobs or daily lives. (Note, the jobs do not have to be science-related!)
7 **Knowing people in science-related roles**	■ Introducing students to people who work in science-related professions – if possible, these interactions should be repeated and involve people with whom students can relate (for example, who grew up in the area, from similar cultural backgrounds). ■ Arranging for STEM Ambassadors to visit the school. ■ Arranging for A-level science students to talk with younger students and share their experiences of studying science post-16.
8 **Talking about science in everyday life**	■ Setting homework tasks that encourage talking with family or peers about science. The aim here is to normalise science talk outside the science classroom.

“I make sure that I am aware of any good documentaries that are on TV. I find that even if just one student watches it, it is a win.”
Teacher

“I try to find and advertise things that are going on and are science-related. I get flyers for events that students can take home.”
Teacher

“I get students to talk to parents at home about what we learn, for example, about stop smoking adverts.”
Teacher

Evidence from research:
Enterprising Science project (King et al., 2015)

From observations and interviews with teachers, we know that teachers intuitively recognise the contribution of each of the science capital dimensions to science learning. The dimensions resonate with their understanding of the many aspects affecting learners' engagement with science. However, few teachers were observed to enact the dimensions in their practice. They would rarely highlight the value of science for leading to all kinds of jobs (science capital dimension 3), proactively encourage students to identify and recognise the science-related knowledge and skills in their own families (science capital dimension 6) or seek to find examples of an individual known to the students who might use science in their daily job (science capital dimension 7).

With practice, teachers became more confident in incorporating family and community understandings of science into their lessons. They were able to use the experiences of parents, local professionals and business people as examples when teaching about the value of science for students' futures. They also developed strategies for promoting science-related talk outside of the classroom (science capital dimension 8) and incorporating science-related media (science capital dimension 4).

Building the science capital dimensions in practice: snapshots from science lessons

Example One

Following a practical activity (comparing the anti-microbial qualities of antiseptics and disinfectants), Ms Marquez says: 'Make sure you wash your hands well. Can someone tell me why this is important?'

Anita mentions that the students may have some microbes on their hands that could cause disease.

Ms Marquez then asks the whole class to think who might need to take special care when washing their hands as part of their daily lives.

Jamie says his dad is a nurse and that he has to wash his hands 'like this', demonstrating the medical hand washing procedure.

Ms Marquez then encourages Jamie to share more about his knowledge of his dad's work. She listens to Jamie's response carefully and comments **'it's great that you talk to your dad about his job. You'll learn lots of interesting things that way.'**

Ms Marquez highlights the value of talking to others, including family members, about science (dimensions 6 and 8).

To the whole class, Ms Marquez says **'Knowing about microbes is important for many different roles and reasons.' She explains that this is important for anyone who works in a place like a hospital, including Jamie's dad. She says it is also important for people who work in the catering industry.**

Ms Marquez talks about the importance of the knowledge about microbes for many different roles (dimension 3).

Next, she asks if anyone else has an example of a situation where a knowledge of microbes and the potential dangers they cause is important.

Zadie says that her mum works in a nursing home. When Zadie went to her mum's workplace in the past, her mum always stressed she should wash her hands well. Ms Marquez repeats Zadie's contribution and **reminds the class that the content learnt in science lessons has practical applications for many sorts of jobs.**

Ms Marquez highlights the transferability of science skills for all sorts of jobs (dimension 3).

Ms Marquez continues: **'Can anyone tell me about any ads on TV for products that work to minimise microbes spreading?'** She asks students to discuss in pairs. Ralph mentions a 'Catch it, bin it, kill it' campaign he saw. A few other students are nodding – they remember this as well. Ms Marquez asks him to describe the advert and then says to the class: 'It's great that you are making these connections. **You could also ask your parents or grandparents what they know—or about ad campaigns they remember—on the importance of making sure microbes don't spread'.**

Ms Marquez asks students about their experience with media – where they might have encountered this topic (dimension 4).

Ms Marquez encourages students to talk about this topic with their parents or grandparents (dimension 8).

Building the science capital dimensions in practice: snapshots from science lessons

Example Two

In a revision lesson at the end of the term about elements, compounds and mixtures, **Mr Campbell asks the class to think about where they might use elements in the home** and to write their ideas on their mini white boards. Mr Campbell circulates around the class and reads aloud 'mercury in thermometers', 'iron pellets for fishing', 'iron taps', 'gold taps'. He then says 'gold is also used in top-end electrical goods as it is a good conductor. There's even gold in my smart phone'.

Mr Campbell draws attention to the value of scientific knowledge in our daily lives (dimension 2).

The students sit up at this comment. Molly asks 'Is that why they're so expensive?' Mr Campbell explains that there are lots of elements, and also compounds, in a phone and some of them are very rare. **He shows a three-minute online video explaining what elements and compounds are used in a smartphone. He says that there are similar videos which explain what TVs and other pieces of electrical equipment are made out of.**

Mr Campbell highlights the value of science media (dimension 4).

Mr Campbell returns to the students' white boards. Ben has written 'silicon in hospitals'. Mr Campbell recognises that Ben is referring to a past experience that the class have spoken about previously. He explains that silicone is a compound made up of the elements silicon, oxygen, hydrogen and carbon. He invites Ben to describe what he knows about silicone. **Ben talks about how the doctors combined types of 'putty' to make the silicone mould that they used to find the shape of his ear for his treatment.**

Ben's description highlights the role of science in all aspects of our lives, and how scientific knowledge and skills are used in a variety of jobs (dimensions 2 and 3).

The lesson continues with Mr Campbell **acknowledging the varied contributions from the class and writing them down on the board under the headings 'elements', 'compounds' and 'mixtures'. He asks questions to ensure that the students understand the difference between the terms.**

Mr Campbell supports his student's science literacy (dimension 1).

Exercises

Identifying science capital dimensions

Read a snapshot from a science lesson below.

- Highlight the science capital dimensions present in the lesson.
- Which other science capital dimensions could Ms Smith include?

Ms Smith recaps the laws of motions discussed in previous lessons. The class talk about the forces acting on moving objects. She asks which will take longer to stop: faster moving objects, or slower moving objects?

The class then review the stopping distances in the Highway Code.

Next, they watch clips of crash test dummies in car crash situations. All are surprised by the amount of damage caused even at low speeds.

Ms Smith then asks the class to think about ways in which the traffic on the roads around the school could be slowed down. Together the class discuss the benefits, and disadvantages, of bumps in the road and other traffic calming measures.

Ms Smith describes the role of town planners in designing road systems that allow cars to move easily, but that are also safe for pedestrians and limit potential accidents. She encourages the class to think about the many science-related skills needed for such a role.

For homework, Ms Smith sets an activity for her students to test their parents' knowledge on stopping distances, and to observe the distance they leave between cars when driving.

Tweaking a lesson plan

Below we present two lesson plans: one it its original form and the other tweaked to include the science capital teaching approach.

- Do both lesson plans allow students to meet the learning objectives?
- Would the tweaked lesson take any more time to prepare?

The lesson forms part of a unit on energy transfer and waves at KS3. The lesson objectives are:

1. To understand that sound is caused by the vibration of particles and that it is a longitudinal wave.
2. To understand that sound travels best through solids.

'Standard' lesson plan

Teacher Activity	Student Activity
Play note on guitar and hit cymbal. Ask what is happening to the string/the cymbal.	Students discuss how they can hear the sound, and what is causing it (vibrations).
Verbally explain how sound is produced, then produce a particle diagram as a class.	Through questioning, pupils suggest how particles vibrate and contribute as teacher draws diagram.
Students discuss in pairs whether they think sounds can be heard in space and why.	Students use the diagram and key words (e.g. particles, vibration) to explain whether or not sound travels in space. (Some may know that there is hydrogen and helium in space).
Ask students to vote on whether they think sound travels best in solid, liquid or gas – ask a few students why they think this.	
Students work in pairs – one student taps on table and other student listens to how the tap sounds. The student then taps the table again with same force, however second student now presses ear against table when listening for the tap.	Students again use their ideas about particles to predict and explain. They complete the tapping experiment. They write their findings and explanation in their books.
Slinkey demonstration – with a (sensible) student demonstrate how longitudinal and transverse waves look using a Slinkey.	Students learn the difference between transverse waves, (e.g., light) and longitudinal waves, (e.g., sound).
Homework: Research how noise (unwanted sound) is reduced. Write half a page + one diagram.	

‘Tweaked’ lesson plan

Teacher Activity	Student Activity	
Students (individually, or in pairs) make sounds any way they like. They could choose to play an instrument (if some are available), sing, clap, beatbox, hum, drum, stamp etc.	**The lesson begins with students’ varied cultural experiences and preferences for music-making being welcomed and valued.**	*BROADENING WHAT COUNTS*
Build on students’ contributions and show varied examples on YouTube of cultural music making.		
Ask what all these forms have in common? Ask students to share their ideas about how sound is produced.	In their own words, they discuss what causes sound, and how they can hear it.	
Invite students to draw diagrams on mini-whiteboards to explain how sound is produced, using their own examples and ideas if they can. Value a variety of responses, and link their descriptions to the scientific terms of particles, vibration etc.		*ELICITING, VALUING AND LINKING*
Give students a conundrum that will **appeal to their particular interests (or let them choose).** For example: “Can you remember if you can hear when underwater?” or “In movies set in space, you often hear spaceships ‘zoom’ away – why is this wrong?”	**Students recognise the value of science for explaining everyday phenomena.**	*PERSONALISING AND LOCALISING* *BUILDING THE SCIENCE CAPITAL DIMENSIONS*
Drawing on their answers to the conundrums, ask students to vote on whether they think sound travels best in solids, liquids or gases.		
Have students work in pairs – one student taps on table and other student listens to how the tap sounds. The student then taps the table again with same force, however second student now presses ear against table when listening for the tap.	Students use their new ideas about sound and particles to predict and explain.	
Ask students for what sort of jobs / activities might it be useful to know about how sound travels? (Discuss DJ-ing, sound recording, working at sea)		*BUILDING THE SCIENCE CAPITAL DIMENSIONS*
Ask if any students are involved in producing their own music and use special equipment or software to do so.		
Slinkey demonstration – with a (sensible) student demonstrate how longitudinal and transverse waves look using a Slinkey.	Students learn the difference between transverse waves and longitudinal waves.	
Homework: Talk with friends and/or family about the quietest part of their home, school, or a local building. In half a page (with diagrams) explain why it is quieter and how the sound is reduced?	**Students engage in science-related talk with friends and family. They learn about the acoustic features of a familiar building.**	*BUILDING THE SCIENCE CAPITAL DIMENSIONS*

The more I use the science capital approach ... the easier it is to plan and keep on track.

Teacher

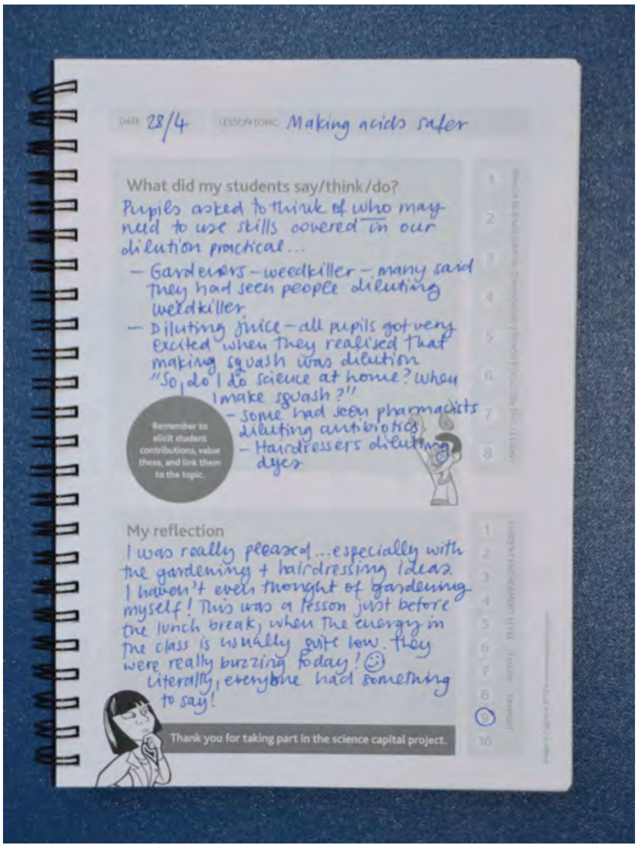
4. RESOURCES

Reflective diaries

To reflect on their successes in using the science capital teaching approach, teachers participating in the project used reflective diaries. These were designed to help teachers capture aspects of their lessons that worked well. They also served as an aide-mémoire: the teachers were able to flick back through their diaries and remind themselves of particular contributions or incidents that prompted rich discussions from their students.

See a photocopiable blank page from the reflective diary in section 5.

What else could you use to capture your experiences and reflections?



Evaluating the progress

The central feature of the science capital teaching approach is teachers' engagement in ongoing reflection. This reflection can take many forms, such as personal reflection and reflection with colleagues.

In order to support your reflection and evaluate your implementation of the approach, you may find it useful to collect some data to help you measure progress. There are no hard and fast rules on what data to collect – the key is to ensure that they are relevant and meaningful to your context and needs. The list below details some of the data sources that teachers and researchers have previously collected and found helpful:

- Student attainment data.
- Student attitudes to learning data.
- Student behaviour data.
- Teacher observations and reflections.
- Student science capital surveys (get in touch with Science Capital Research team!).
- Examples of student work.

Responding to frequently asked questions

Won't this take a lot of time?

Reflecting on one's practice and thinking about making changes does take time. However, most of the teachers who have adopted the science capital teaching approach have found that their planning time decreases over time as the new way of thinking about lessons becomes habitual.

> *"The more I use the science capital approach and the more it becomes a part of everything that I'm doing, the easier it is to plan and keep on track."*
> ***Teacher***

> *"I don't feel like it's been onerous. I feel like it's just been working in a different way, rather than extra work."*
> ***Teacher***

How can I value off-topic contributions and keep the discussion on track?

Managing class discussions can be difficult. The more open the question, the more varied the responses, and the harder it can be. The art of teaching has long involved the management of off-topic contributions and the re-alignment of comments back to the class discussion, so this task is not new. The science capital teaching approach emphasises how important it is for teachers to elicit student contributions, and particularly those based on students' own cultural or community knowledge, in order for students to feel valued and see that their comments contribute to the lessons.

Over time, such valuing can help students come to see science as potentially for them.

One of the most challenging aspects is to link various contributions to curriculum science. It may be that the contribution can be used more appropriately in a future lesson, in which case it is worth making a note to do so.

Use think-pair-share and small group discussions to capture the contributions that students see as most relevant. It can also be very helpful to observe how other teachers (not necessarily science teachers) manage class discussions. Focus your observations on how those teachers elicit, value and link what students have to say.

Should I be including all the science capital dimensions in each lesson?

It is unlikely that you will be able to include all the dimensions in a single lesson. Inviting people with science backgrounds into lessons (science capital dimension 7) will probably be a special event! Teachers have found, however, that over the course of a scheme of work it is possible to incorporate all of the dimensions.

How does the science capital teaching approach fit with practical work?

Some students have practical skills they have developed outside school and it is just as valuable to be able to elicit and value these during lab-based lessons as it is for other knowledge and ideas.

“When we did a recent practical, we talked about who would need to collect data accurately in their jobs.”
Teacher

The students appear more engaged in lessons, but are they learning more?

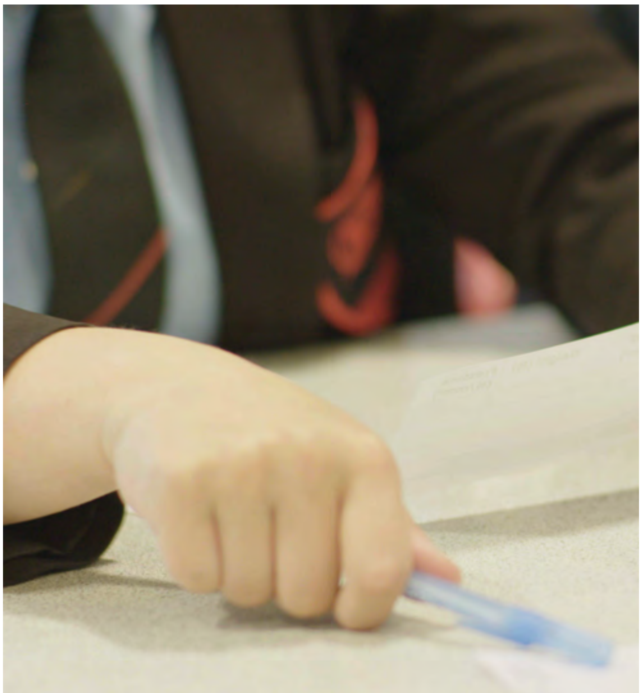
The science capital teaching approach helps students to connect with and make sense of the science content in meaningful ways. This can help students recall the science content. Indeed, teachers using the science capital teaching approach have reported significant gains in learning. And as one student put it ‘the science sticks in your head more’.

Does adopting the science capital teaching approach mean diluting science content?

The approach is specifically designed to allow teachers to follow their usual curriculum content. There is no dilution of the actual science that students learn. The difference is in the way science content is presented, framed and related to students’ lives and in how students are supported to engage with the science content. The approach is not changing what content is taught but the way it is taught.

But I am doing all this already!

That’s brilliant! We hope that this pack might give you some additional ideas about how to engage your students with science. How could you share your good practice with others?



“Being in an underprivileged area, we need strategies to make subjects important. Students need to see that it is important for them, and the reason why we’re doing it. When they have a reason, they get stuck in. When they don’t have a reason, they don’t care.”
Teacher

Additional resources from the Enterprising Science project

Project videos

- **Science Capital – an introduction** animation, available at: bit.ly/sciencecapitalexplained
- **A Science Capital approach to building engagement** animation, available at: bit.ly/SciCapEngagement
- **The Science Capital Teaching Approach** animation, available at www.ucl.ac.uk/ioe-sciencecapital
- **Science Capital in the Classroom** videos, available at: bit.ly/SciCapClassroom
- **The Science Capital Teaching Approach** video, available at www.ucl.ac.uk/ioe-sciencecapital
- **Science Capital Seminar** videos, available at: bit.ly/SciCapSeminar

Short summary publications about science capital and the science capital teaching approach

- Archer, L. & King, H. (2017) **Want to engage young people in STEM subjects? You need to start getting personal: how to boost your students' science capital.** Teachwire. Available at: bit.ly/SciCapTeachwire
- Archer, L. (2017) **Happier teachers and more engaged students? Reflections on the possibilities offered by a pedagogical approach co-developed by teachers and researchers.** Research in Teacher Education, 7(1), 29-32. Available at: bit.ly/SciCapRiTE
- Mytum-Smithson, J. (2017) **Science is for everyone.** Secondary and post-16 STEM Learning magazine, 5, 14-15.
- Archer, L., Dawson, E., DeWitt, J., Godec, S., King, H., Mau, A., Nomikou, E. & Seakins, A. (2016). **Science capital made clear.** London: King's College London. Available at: bit.ly/SciCapMadeClear
- Arney, K. (2017) **Theories of everything.** TES. Available at: bit.ly/SciCapTES

Academic publications

- Archer, L., Dawson, E., DeWitt, J., Godec, S., King, H., Mau, A., Nomikou, E. & Seakins, A. (2017). **Killing curiosity? An analysis of celebrated identity performances among teachers and students in nine London secondary science classrooms.** Science Education, 101(5), 741–764.

- Archer, L., Dawson, E., DeWitt, J., Godec, S., King, H., Mau, A., Nomikou, E. & Seakins, A. (2017). **Using Bourdieu in practice? Urban secondary teachers' and students' experiences of a Bourdieusian-inspired pedagogical approach.** British Journal of Sociology of Education. Advance online publication. Doi: 10.1080/01425692.2017.1335591

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- Archer, L., Nomikou, E., Mau, A., King, H., Godec, S., Dawson, E. & DeWitt, J. (under review) **Can the subaltern 'speak' science? An intersectional analysis of performances of 'talking science through muscular intellect' by 'subaltern' students in UK urban secondary science classrooms.**

- Archer, L., Dawson, E., Seakins, A., DeWitt, J., Godec, S. & Whitby, C. (2016). **"I'm being a man here": urban boys' performances of masculinity and engagement with science during a science museum visit.** Journal of the Learning Sciences, 25(3), 438-485.

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- Archer, L., Dawson, E., DeWitt, J., Seakins, A. & Wong, B. (2015) **"Science capital": A conceptual, methodological, and empirical argument for extending Bourdieusian notions of capital beyond the arts.** Journal of Research in Science Teaching, 52(7), 922-948.

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Students need to see the reason why we're doing it. When they have a reason, they get stuck in.

Teacher

5. APPENDIX: PHOTOCOPIABLE MATERIALS

This appendix provides photocopiable material related to earlier sections of the pack.

- Thinking about science and ‘sciencey’ people (see Foundation: Broadening what counts)
- Student questionnaire (see Pillar two: Personalising and localising)
- Home questionnaire (see Pillar two: Personalising and localising)
- Blank reflective diary

Thinking about science and 'sciencey' people

Which of these best describes how you see yourself? (please tick)

I am very into science	☐
I quite like science	☐
I'm not that into science	☐
I really dislike science	☐

Can you name anyone in your class who you'd describe as a 'science person'?

Think about your class. How important are the following characteristics in determining if someone is a 'science person'?

	Very important	A bit important	Not important
1. Being naturally clever	☐	☐	☐
2. Getting the answer right	☐	☐	☐
3. Using scientific language and terms	☐	☐	☐
4. Shouting out the answer	☐	☐	☐
5. Being curious	☐	☐	☐
6. Working hard	☐	☐	☐
7. Discussing ideas with others	☐	☐	☐
8. Sharing views and experiences	☐	☐	☐
9. Being creative	☐	☐	☐

Student questionnaire

1. What do you like to spend time doing outside of school? (e.g., hobbies, interests)

2. What are your favourite things to view on TV or online?

3. Do you have a specific job you'd like to do when you are older?
   If so, what is it and why this job?

4. Do you know anyone who already works in this job? Who?

5. Is there anyone you look up to or admire? Who and why?

Home questionnaire

Interview a parent or someone close to you.

1. Which of these skills do you think are key in science? Tick all that apply.

☐ Observation	☐ Testing	☐ Communication skills
☐ Imagination	☐ Creativity	☐ Visualisation
☐ Curiosity	☐ Negotiation	☐ Co-operation

2. Which of the following skills, if any, do you use in your everyday life? Tick all that apply.

☐ Observation	☐ Testing	☐ Communication skills
☐ Imagination	☐ Creativity	☐ Visualisation
☐ Curiosity	☐ Negotiation	☐ Co-operation

3. What is your daily activity or occupation?

4. What skills do you use in this activity or occupation?

5. Would you be interested in telling us about the work you do in our science lessons?

Reflective diary

DATE:

LESSON TOPIC:

What did my students say/think/do?

WHICH SCIENCE CAPITAL DIMENSIONS DID YOU FOCUS ON THIS LESSON?

1 2 3 4 5 6 7 8

Remember to elicit student contributions, value these, and link them to the topic.

My reflection

STUDENT ENGAGEMENT LEVEL 1=LOW 10=HIGH

1 2 3 4 5 6 7 8 9 10

Thank you for taking part in the science capital project.

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M. White	

This resource pack was written by:
Spela Godec
Heather King
Louise Archer

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If teachers don't feel like they have the opportunity to engage with authentic human experience that develops their students as emotional, social, intellectual and moral people they may not stay in the classroom and students will only learn the material that helps them succeed on the tests.

Dr Rebecca Buchanan

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Further information:

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

For any additional information, please contact:
ioe.sciencecapital@ucl.ac.uk

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