

IMPROVING SCIENCE PARTICIPATION

Five evidence-based messages for
policy-makers and funders



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To continue with science post-16, young people must achieve certain levels of understanding and attainment. But, crucially, they must also feel that they fit in with science and that science is 'for me'.

Drawing on over five years of research conducted by the Enterprising Science project in classrooms and out-of-school settings, we have developed five key messages for policy-makers and funders who want to improve (widen and increase) young people's engagement with science.

Together, these messages form an evidence-based action agenda for policy and funders across both formal and informal settings. This agenda is founded on an educational approach that has been found to significantly improve young people's attitudes, post-16 aspirations and relationship to science.

1 Ensure that, within your context, young people's encounters with science (in and beyond the classroom) are based on the science capital educational approach.

2 Focus on changing institutional settings and systems – rather than young people.

3 Take the long view: move from one-off to more sustained approaches.

4 Use science capital survey tools appropriately.

5 Improve connectivity: create pathways, progression and partnerships.

Participation rates in post-compulsory science, particularly the physical sciences and engineering, are unequal and seemingly resistant to change.¹

To ensure the supply of future scientists, technicians, programmers and engineers, as well as foster a scientifically literate population, it is essential to widen and increase participation, particularly by those from under-represented groups, including women and individuals from working-class and some minority ethnic backgrounds.²

Conceptual Basis – Science Capital

Our research has shown that the concept of science capital can help explain variable rates of science engagement and participation across formal and informal settings. It can also help to frame interventions designed to support engagement.

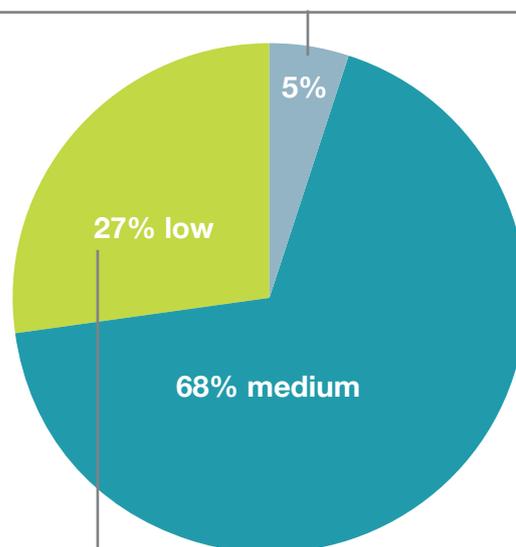
Background

The concept of science capital originally emerged from the ASPIRES project³, a ten-year longitudinal study of the development of the science and career aspirations of young people from ages 10 to 18. This work has continued in Enterprising Science, a five-year research and development project partnership between UCL Institute of Education, King's College London, BP and the Science Museum Group.

Our analyses show that the more science capital a young person has, the more likely they are to aspire to study science in the future. Young people who have low levels of science capital tend not to see themselves as 'sciencey' and are less likely to want to continue with science. Students who do not see science as meaningful and relevant to them find it more difficult to engage with the subject.

Our national survey 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.⁴

5% of young people have high levels of science capital

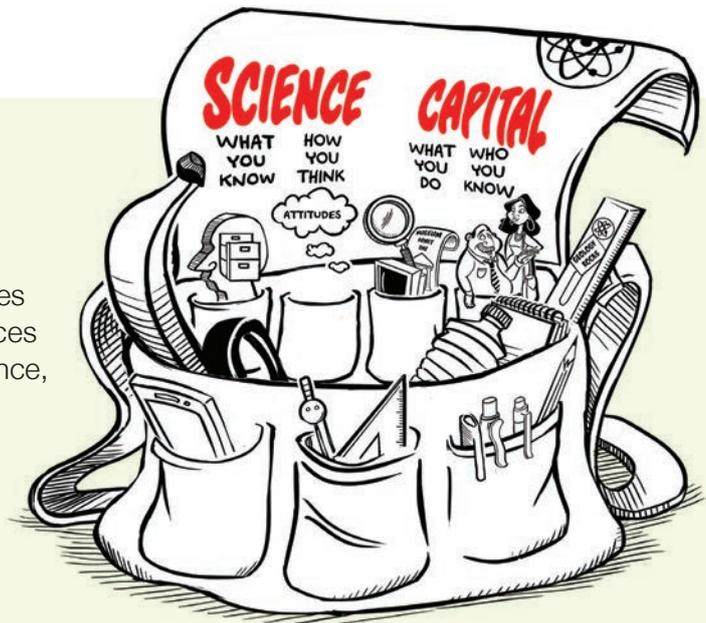


27% of young people have low levels of science capital

A brief guide to science capital

The concept of science capital encapsulates all of an individual's science-related resources – their attitudes and understanding of science, science-related interests and activities and social contacts.

It can be useful to think of a person's science capital as a bag, or holdall, containing what they know, what they think, what they do, and who they know related to science.



Our research has identified eight key dimensions of science capital:

- 1. Scientific literacy:** an individual'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 an individual 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 one engages with science-related media including television, books, magazines and internet content.
- 5. Participation in out-of-school science learning contexts:** how often an individual 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 person's family have science-related skills, qualifications, jobs and interests.
- 7. Knowing people in science-related roles:** the people an individual 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 an individual talks about science with key people in their lives (e.g., friends, family members, neighbours, community members).

Using a science capital approach to engage young people with science

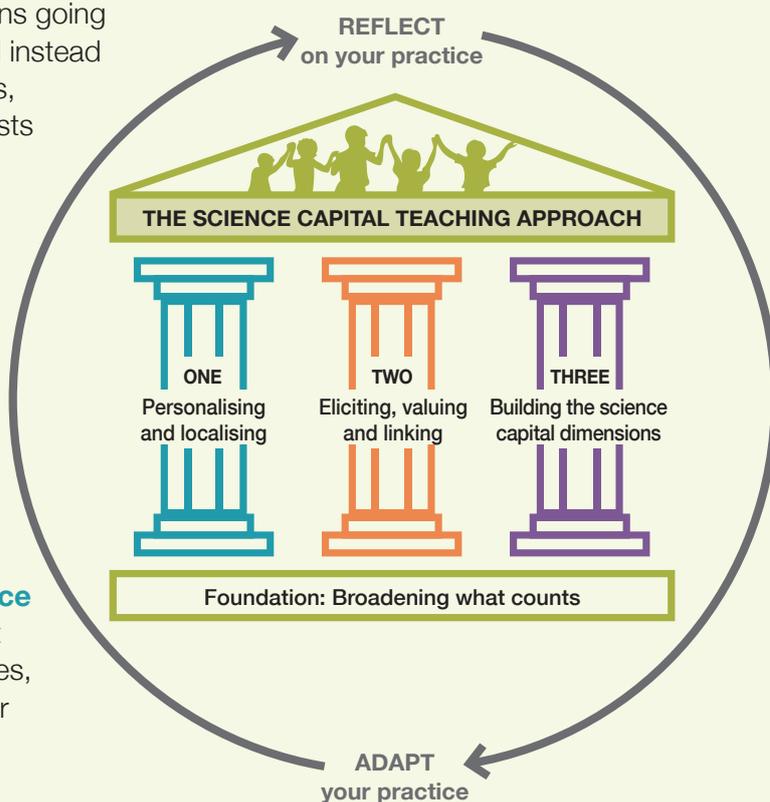
Working in partnership with teachers we developed an educational approach for enhancing young people’s engagement with science. The approach builds on the insight that in order to participate, young people must feel that science is ‘for me’.



The approach does not require changes to course content or extra planning. Rather, it involves small, but significant, changes in the educator’s mind set.

The Science Capital Teaching Approach

- **Foundation: Broadening what counts** involves creating a learning environment where all feel able to offer contributions from their own experiences, interests and identities.
- **Personalising and localising** means going beyond contextualising content, and instead connecting to the actual experiences, understandings, attitudes and interests of individuals, in or outside of the classroom.
- The technique of **elicit-value-link** involves using questions that invite individuals to share knowledge, attitudes, experiences (eliciting), recognising these as having value in that context (valuing), and connecting back to the science content at hand (linking).
- **Building the dimensions of science capital** means considering the eight dimensions when developing activities, programmes, interventions and other initiatives, whether in school or out-of-school contexts.

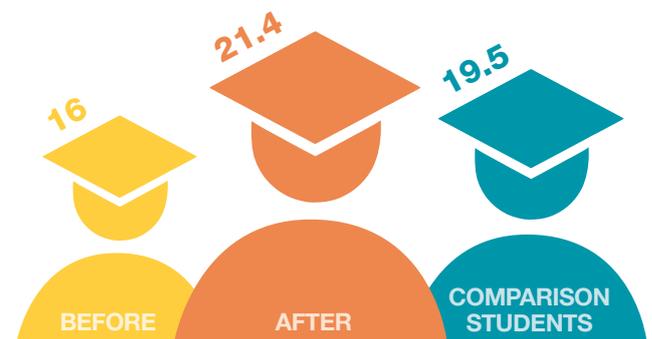


Partner schools were selected on the basis that they served socio-economically challenged communities and students recorded low levels of science capital (significantly below the national average). Analysis showed that implementing the science capital approach significantly:

- Improved young people's understanding and recall of science content.
- Helped young people find science more personally relevant.
- Deepened young people's appreciation of science.
- Widened and increased young people's engagement with science in lessons.
- Improved students' behaviour during science lessons.
- Increased the proportion of young people seeing themselves as 'sciencey'.

For instance, after one year of implementation of the science capital approach in their classrooms, the percentage of students expressing an interest in studying at least one science subject at A-level increased significantly, from 16% to 21.4%, closing the gap with comparison students (19.5%).⁵

Change in students' interest to study science at A-level following implementation of approach.



The Evidence Base

The science capital approach was co-developed and trialled over four years by 43 science teachers (Key stages 3 and 4) in secondary schools in London, Leeds, York and Newcastle and a range of data was collected on the process of implementation, student progress, understanding, attitudes and behaviour. Qualitative data collected included 201 observations of lessons and museum visits (by students and their families), 55 teacher interviews, 34 interviews with students and their families, and 53 focus groups with students (4-6 per group). In addition, surveys were conducted with over 22,000 students in Years 7-11. Intervention students were surveyed at the beginning and end of the trial year, to provide pre/post test data.

1 Ensure that, in your setting, young people's science encounters (in and beyond the classroom) are based on the science capital approach

Qualitative and quantitative data show that over the course of a year, teachers who used the science capital approach recorded significant improvements in young people's attitudes to science, their aspirations for studying science at A-level and a host of other benefits.⁶

While developed in secondary science classrooms, the principles underpinning the approach are applicable across a wide range of other contexts, including primary schools and informal settings, such as science centres, museums and other organisations concerned with science engagement and communication.

“ I see a lot more engagement, I see a lot more excitement. ... Their attitude is changing, they're wanting to be involved and they're enjoying it. ”

Teacher, Newcastle

“ We infuse science capital through everything that we do. ”

Education Director of Science Centre, Southern England

Action points:

- Disseminate the science capital teaching approach handbook and associated resources to educators in your organisation/field.
- Support and enable staff to take part in professional development opportunities to receive training in the science capital approach and to understand and operationalise the principles.
- Support educators within your organisation/setting (e.g. provide encouragement, time, fora, resources) to engage in reflective practice around implementing the approach.
- Support wider staff (e.g. senior managers, staff in other departments) to also be aware of the approach and its principles.
- Support educators to share their experiences of trying out the approach with colleagues, both within and beyond the organisation/setting.

2

Focus on changing your setting and systems – rather than young people

To date, many attempts to increase engagement with science, whether in the classroom or the informal sector, have focused on the young person – trying to identify ways they need to be fixed or changed. Instead, the science capital approach focuses on changing settings, or what is termed, the ‘field’. Field is a sociological concept⁷ that relates not only to a physical setting, but also encapsulates the range of social relations, expectations and opportunities in a given environment.

By focusing on changing settings and systems (rather than individual young people) in line with the science capital approach and principles, teachers who trialled our approach saw significant improvements in young people’s attitudes, aspirations, understanding and behaviour.

Changes to the field do not go unnoticed by young people. For instance, trials of the approach showed that the proportion of students reporting that their teachers asked about their experiences and ideas in every lesson increased from 17.7% to 26.2% following the intervention.⁸

The analogy of a burning candle can be used to think about engagement with science and the role of field.



- The flame represents an individual’s engagement with science. How well it burns and whether it flickers or is constant will vary across contexts and over time.
- The candle represents a person’s attitudes, dispositions and capital.
- The heat to spark the flame can come from any encounter with science – in the classroom, from a museum educator, at a science festival.
- The field – the air, conditions and environment surrounding the candle – determines whether the flame stays lit and how brightly it burns.

Action points:

- Prioritise strategy, approaches and initiatives that foreground professional reflection on, and analysis of, existing practice (e.g. what sorts of messages does our practice and setting send about who science is for and what/who is valued as legitimately ‘sciencey’?)
- Map and review the demographics of staff. Check whether different communities are represented in the staff profile.
- Direct resources towards initiatives that promote and embed a science capital approach, particularly at a strategic or systemic level.

3

Take the long view: move from one-off to more sustained approaches

Engaging more – and more diverse – young people with science is not an easy goal and requires more than a simple quick fix. Whether in schools, or informal settings, changing the field takes time and requires reflection.

Our partner schools implemented the approach over the course of an academic year, with multiple cycles of reflection. This sustained approach produced significant changes: the students' science capital scores increased from 38.18 to 40.80 – a statistically significant increase which also represented a closing of the gap with comparison students.⁹

Participating teachers often credited this more reflective approach with improvements in students' attitude, behaviour and attainment.

“ I’ve got more pupils who are achieving their minimum expected grade, as opposed to teachers who aren’t using the science capital approach. ”

Teacher, York

“ The first set of data I had for them... I think I got two in the class who maybe got a grade 1 and the rest failed. Whereas now they’re all working grade 4 or 3. So there’s been a huge leap. ”

Teacher, Newcastle

Action points:

- Review the portfolio of activities that you support and ensure you have developed a strategy for achieving an appropriate balance between one-off interventions and more sustained, impactful work of the sort that could foster the development of science capital.
- Encourage and support an embedded, systematised approach to strengthening professional reflection and sharing good practice and experiences of implementing the approach. Ideally this will not be tied to short-term projects or purely externally-driven initiatives.
- Incorporate support/embedding of the science capital approach within mainstream evaluation and strategic planning, such as through specific goals to build science capital among young people, or set targets to increase the proportion of visitors with low science capital.

4

Use science capital survey tools appropriately

Over five years, the Enterprising Science project has developed a survey instrument to measure young people's science capital. There is a full length version, which covers many different areas and collects a range of attitudinal, behavioural and demographic data. The longer survey has also been shortened into a more concise 'index' of science capital, consisting of 14 statistically derived key items, which – like the main survey – can be delivered online or offline.

Index of Science Capital

This survey can be used to measure the levels of science capital within a target group, such as school students or visitors (or non-visitors) to an informal setting. It provides a mix of attitudinal and behavioural measures to provide a rich insight into the science capital of participants.

Using the science capital surveys

Data from the surveys are best suited to informing reflective practice – to help educators, organisations, policy-makers and funders to understand communities of interest in new ways and to aid reflection on how settings might better support their science engagement.

The survey can also be used to measure changes resulting from sustained, longer-term interventions. It is not appropriate for measuring changes or impacts from short-term and one-off interventions or experiences.

In the absence of a long-term intervention, collecting survey data can still be useful to inform reflective practice. For instance, our ongoing work developing an adult index of science capital has highlighted that feeling 'at home' in settings where science is discussed and practised is a central dimension.

Action points:

- Use the survey tools to generate a profile of the science capital of the young people/adults within your setting. Use this data to support reflection and inform both strategy and practice.
- If conducting longer-term or more sustained intervention work, consider doing pre- and post-surveys with both intervention and comparison groups, to gain a sense of the impact of the intervention.
- Contact our team for copies of the student and/or adult science capital surveys and for advice on how to interpret the data: ioe.sciencecapital@ucl.ac.uk

5

Improve connectivity within and between settings: create pathways, progression and partnerships

Organisations and institutions, whether schools, science museums or festivals, do not exist in isolation and nor do audiences and participants experience these offers in isolation. Yet, there is a lack of joined-up thinking and action within and between these settings.

Evidence shows that young people with high science capital report engaging with science across a range of settings – for instance, at school, through their leisure activities and the media, and through their personal relationships. For these young people, their science engagement is supported across a rich, interconnected web of relations and experiences. They benefit from clear science pathways, helping them to navigate between experiences and settings as part of a trajectory of ongoing science participation.

But not all young people experience such pathways – the experiences of students with low science capital are more akin to ‘dead ends’ and disconnects.¹⁰ Science capital is generated across a range of experiences, hence greater connectivity within and between settings should help build science capital and support science engagement. Research shows that when individuals can connect their experiences across settings, engagement can flourish.

Taking an ecological perspective on science engagement, that is, paying attention to supporting connections and trajectories between different settings, can be productive for supporting engagement, for individuals from a wide range of backgrounds.¹¹

Action points:

- Support staff to map a selection of young people’s/adults’ pathways within and through your setting. Reflect collectively to identify points of progression and blockage over time and work to understand what facilitates or hinders different trajectories.¹²
- Undertake a mapping of your organisation’s points of connection and partnership with other settings – identify to what extent you are collectively enabling trajectories of ongoing science engagement (e.g. within and between formal and informal offers). Are there any cliff edges, for instance where interventions do not provide a clear next step for continuing engagement? Identify points for improving connectivity – communicating next step possibilities both within and beyond your own setting.



FURTHER INFORMATION

Additional publications about science capital

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

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

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.

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

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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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Archer, L., & DeWitt, J. (2017). *Understanding Young People's Science Aspirations: How students form ideas about 'becoming a scientist'*. London: Routledge.

- 4 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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