Institution: University College London

Unit of Assessment: UoA 23 Education

Title of case study: Better Policy and Practice to Support More Equitable Science Participation

Period when the underpinning research was undertaken: March 2017 to 2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
Louise Archer	Karl Mannheim Professor of Sociology of Education	March 2017 to present
Spela Godec	Research Associate	February 2016 to present
Meghna Nag Chowdhuri	Research Fellow	October 2019 to present
Julie Moote	Senior Research Fellow	March 2017 to present
Jennifer Dewitt	Senior Research Fellow	March 2017 to present
Ada Mau	Research Associate	February 2014 to present

Period when the claimed impact occurred: March 2017 to 2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact (indicative maximum 100 words)

Increasing and diversifying participation in science remains an urgent but intractable global challenge. Building on their own original concept, Professor Archer and her team researched, developed and trialled the Science Capital Teaching Approach (SCTA). This innovative pedagogical approach is now in wide use, helping primary and secondary school teachers and science learning organisations to support diverse students find more meaning and relevance in science and, as a result, engage more productively with the subject. The SCTA research has created a step-change in how issues are understood and addressed in science education in over 80 countries, helping varied sectors to change their practice to reduce barriers to science participation for millions of young people and improve professional capacity internationally.

2. Underpinning research (indicative maximum 500 words)

The research base comprises two main studies, ASPIRES 2 and Enterprising Science, which originated at King's College London (KCL) and moved to UCL Institute of Education (IOE) on 1 March 2017. The work is being continued through the ongoing Primary Science Capital Teaching Approach project (2019–2021, led by UCL). This IOE case study focuses on the research and impact on practice relating to the SCTA (from 2017 to date). The policy impact of the research (from research conducted prior to 2017) will be submitted as an impact case study by KCL.

ASPIRES2 'Young People's Science and Career Aspirations age 14-19', funded by ESRC (2014–2019) Outputs from this grant: see references **R1, R2, R3**.

ASPIRES2 builds on the first ASPIRES study (2009–2014) from which the concept of science capital originated. The ASPIRES2 research undertook surveys with over 40,000 pupils and longitudinal interviews to study the development of young people's science aspirations and participation, aged 14–19. Data included views and experiences of science, technology, engineering and mathematics (STEM), subject preferences and choices, participation in STEM activities in and out of school, and parental and peer attitudes. Qualitative data were analysed using a feminist, intersectional Bourdieusian sociological lens. The study identified how science-related forms of habitus and capital help explain gendered, classed and racialised trends in science participation **(R1)**. It showed that while the majority of young people report finding school

science interesting, only about 16 per cent aspire to a career in science. The study found that common educational practices in school science are a large contributor in whether or not students continue to study science post-16, such as the ways in which physics is taught discouraging many girls further participation **(R2, R3)**.

Enterprising Science, funded by BP GBP1,600,000 (2012–2018) Outputs from this grant: see references **R4, R5, R6**.

The Enterprising Science project, a research and development partnership between UCL, King's College London and the Science Museum, further developed the conceptual framework of science capital **(R5)** and worked with teachers to co-develop the SCTA **(R4)** as a way to build young people's science capital and enable more young people to experience science as being 'for me' **(R6)**. The approach builds on good teacher 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. Teachers 'tweak' and adapt their practice through the four key components of the model: broadening what and who counts in science in order to value students and support their agency; personalising and localising science; eliciting, valuing and linking students' existing identities, experiences and cultural knowledge; and embedding the science capital dimensions in learning.

The research-based SCTA **(R4)** can be used with any curriculum. It was co-developed with 43 secondary science teachers and 1,200 students over four years **(R6)**. It is available in print and online as a free, 64-page teaching resource, in English and Welsh. Due to increased interest and demand, organisations outside of the UK have produced Norwegian and Hebrew versions. It provides practical examples and tools, developed with teachers, of how to adapt existing lesson plans and activities to help build students' science capital. The SCTA is designed to change power relations and the dominant ways in which science is currently presented, framed and related to students. Existing STEM interventions often adopt an individualistic and deficit-oriented approach. Instead, the SCTA focuses on changing what Bourdieu terms the 'field' rather than the student, for example by changing pedagogy to broaden what gets recognised as a valued way of doing science. It uses an assets-based approach that supports educators to value what students bring with them.

Evidence from two trials of the SCTA showed significant increases in students' science capital, science A level aspirations and positive attitudes to science **(R5, R6)**. A similar primary school resource is now being co-developed with primary school teachers. The new primary research and development project is supported and funded by two science education charities, Primary Science Teaching Trust (GBP120,000) and The Ogden Trust (GBP80,000).

3. References to the research (indicative maximum of six references)

R1 Moote, J. Archer, L., DeWitt, J. & MacLeod, E. (2019) Who has high science capital? An exploration of emerging patterns of science capital among students aged 17/18 in England, *Research Papers in Education*. https://doi.org/10.1080/02671522.2019.1678062
R2 Archer, L., Moote, J. & MacLeod, E. (2020) Learning that Physics is 'Not for Me': Pedagogic Work and the Cultivation of Habitus among Advanced Level Physics Students, *Journal of the Learning Sciences*. https://doi.org/10.1080/10508406.2019.1707679
R3 Archer, L., Moote, J., Francis, B., DeWitt, J. & Yeomans, L. (2017) The "Exceptional" Physics Girl: A sociological analysis of multimethod data from young women aged 10–16 to explore gendered patterns of post-16 participation, *American Educational Research Journal*, 54(1), 88–126.https://doi.org/10.3102/0002831216678379
R4 Godec, S., King, H. & Archer, L. (2017) *The Science Capital Teaching Approach: engaging students with science, promoting social justice.* London: University College London. https://discovery.ucl.ac.uk/id/eprint/10080166/1/the-science-capital-teaching-approach-pack-for-teachers.pdf
R5 Archer, L., Dawson, E., DeWitt, J., Godec, S., King, H., Mau, A., Nomikou, E. & Seakins, A. (2018) Using Bourdieu in practice? Urban secondary teachers' and students' experiences of a

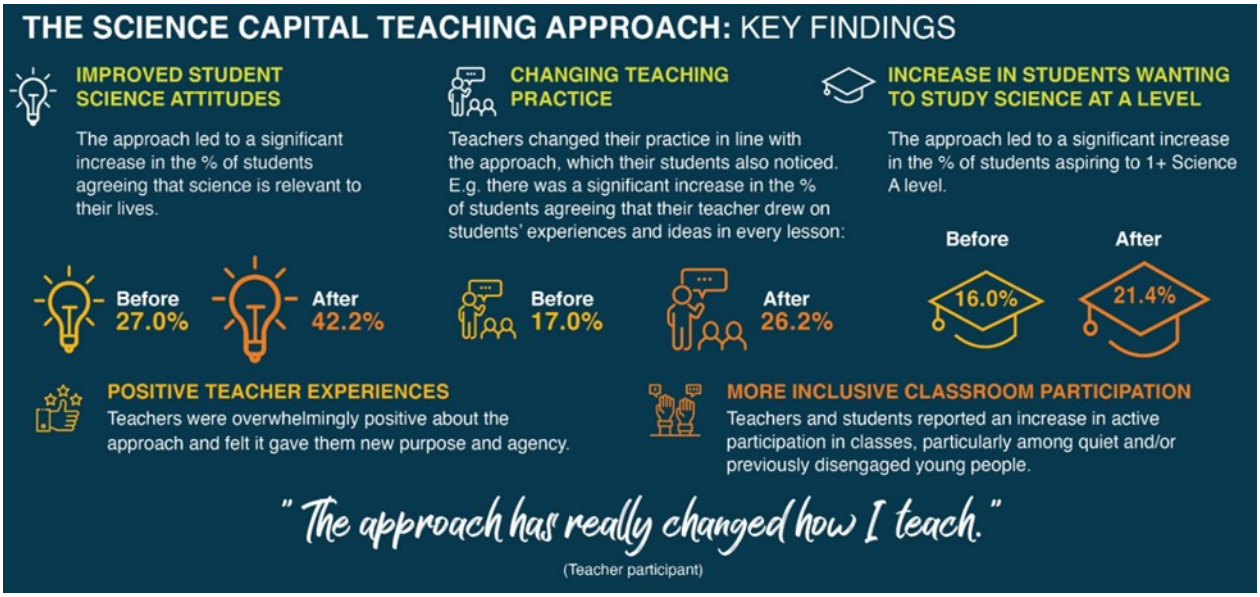
Bourdieusian-inspired pedagogical approach, *British Journal of Sociology of Education*, 39(3), 283–298. https://doi.org/10.1080/01425692.2017.1335591
R6 Godec, S., King, H., Archer, L., Dawson, E. & Seakins, A. (2018) Examining student engagement with science through a Bourdieusian notion of field, *Science & Education*, 27(5–6), 501–521. https://doi.org/10.1007/s11191-018-9988-5

Research quality indicators: publications that have been through a rigorous peer review process and sustained funding from the ESRC including ASPIRES 3 from January 2020 to January 2023 (GBP 843,856). This research has been widely recognised for its outstanding quality and impact, winning the BERA Public Engagement and Impact Award in 2018 and the ESRC Celebrating Impact Award in 2019.

4. Details of the impact (indicative maximum 750 words)

School science and informal science learning (ISL) have long struggled to engage a broad demographic in science. Traditional thinking has tended to pose the problem as being a 'deficit' in reluctant learners, whether girls or students from under-represented backgrounds. By applying sociological and educational theory, and working in partnership with teachers and ISL practitioners, Archer and her team at the IOE have galvanised a step-change in innovation in both formal and informal sectors, leading to significant impacts on practice and on the wider discourse about science learning. Much of this change has been operationalised through the SCTA.

Impact on school science education
The SCTA was published online in 2017. Analysis of survey data from 1,871 students together with observation, discussion group and interview data from 16 classes collected during two year-long trials of the SCTA in secondary schools, found that it resulted in significant increases in student science capital, intentions to study one or more science A levels, and positive attitudes to science **(S1)** as illustrated in this infographic.



Teachers also reported gains in students' attainment and that students were more engaged, with less classroom disruption when they use the SCTA. Similar patterns of change have also been recorded by teachers from ten participating schools in the Primary SCTA project, including dramatic changes in engagement among a group of high attaining girls who previously had low science engagement, through to a complete transformation of the learning culture in some classes **(S2)**. The CEO of The Ogden Trust has underlined the value of the SCTA to the secondary curriculum and the importance of extending the research to the primary curriculum, by funding the development and publication of a primary education teaching resource, 'Capturing impact: evaluation toolkit' **(S2)**.

Through the research team's active dissemination strategy, there has subsequently been widespread uptake of the tools and resources in over 83 countries to date, leading to changes in how teachers and informal science educators engage with young people, most notably in the UK, the US, Spain, Scandinavian nations and Australia. Over 4,000 teachers have directly engaged with the approach, in turn reaching more than 600,000 students. Nearly 2,500 hard copies of the SCTA have been requested, and in the past year alone the handbook has been downloaded over 4,600 times from 86 countries. Three short videos for teachers have been viewed more than 14,300 times.

Since 2017, the team has delivered training on the SCTA to over 40 organisations in the UK, including teacher professional development networks such as the Institute of Physics' regional officers **(S3)** as well as international training (e.g. Ireland, Malta, Denmark, Norway, Israel). The impact of the research on developing new understanding and building capacity in the science education sector has been described as 'transformative' by the Institute of Physics. Training for teachers in the approach has also been cascaded by partner organisations, including:

- The Institute of Physics (IOP) funded an eight-month '*bespoke SCTA training programme for 12 of their Regional Network Coordinators*' **(S3)** to introduce and embed the SCTA in primary and secondary physics teachers' daily practice.
- The Ogden Trust has distributed the SCTA as a '*ready to use, practical resource to over 500 teachers*' **(S2)**, both in secondary and primary schools and is '*co-funding a project to develop a Primary Science Capital Teaching Approach*' **(S2)**. The Chief Executive of the Trust says: '*We have used Science Capital to help us identify priority audiences…to change the focus of our programmes to be more effective*' **(S2)**.
- In 2019, the Greater London Authority funded the integration of the SCTA into its London Curriculum (a free resource available to all schools in London, over 3,000 schools), and in 2020 funded a well-received *'professional development workshop for 100 London primary and secondary teachers*' **(S4)** focusing on the SCTA. Evaluation was 100% positive, showing teachers were highly engaged and "full of praise", as stated in the GLA contact email after.
- Through dissemination of the SCTA, science capital has been introduced as a marker for excellence within the Primary Science Quality Mark, a national award programme to celebrate science in primary schools. Schools applying for the award must prove '*a commitment to developing all children's Science Capital*'. Over 11% of schools currently have this award **(S5)**.

Impact on informal STEM learning and outreach

In addition to the 600,000 plus school students globally impacted by the SCTA, it has underpinned a significant transformation in approaches to informal science learning (ISL) and STEM outreach. Staff working in these settings have changed their practice based on the principles of the approach: for example, building science capital dimensions; eliciting, valuing and linking students' existing identities, experiences and cultural knowledge to the science content; starting with the child, supporting students' agency and voice. In the process they have shaped the experiences of millions of visitors at science centres, museums and other informal science learning settings. Evidence of this impact in the UK can be seen in the activity of the National Forum for Public Engagement in STEM, a collective of key funders and organisations involved in setting the national agenda for public engagement in STEM, including Wellcome, UKRI and the Royal Society. Since 2017 the Forum has invited Archer to present her work on three occasions and '*Forum members have chosen to formally adopt Science Capital to inform our collective work. As is explained on the Forum website: "We believe that Science Capital provides a very productive platform to think differently and more profoundly about the factors which affect people's engagement with science*"' **(S6)**.

The Director of the National Coordinating Centre for Public Engagement, and a member of the Forum commented: '*Science Capital and SCTA has galvanised a paradigm shift in the quality of debate and experimentation with new approaches to informal STEM learning – galvanising interest and excitement amongst teachers, public engagement professionals and policy makers. The theory has been mobilised through highly adaptable tools and frameworks which professionals can quickly adapt to transform their practice*' **(S6)**.

A National Forum survey of STEM engagement professionals in 2019 revealed that '64% of respondents agreed or strongly agreed that the concept of science capital had informed their work' **(S6)**. STEM engagement professionals are not only using science capital at the core of their practices, but also finding it a valuable tool to reach underserved audiences, contributing to a step change in Informal Science Learning policy and practice **(S6)**. This impact is most obvious in re-shaping pedagogy for working with underserved communities, and in exhibit design and interpretation for millions of science centre visitors. Examples include the Science Museum Group, Glasgow Science Centre, Newcastle's Centre for Life, Sweden's Tom Tits Experiment, Poland's Copernicus Centre, and the Francis Crick Institute in London. The Science Museum Group and the Association for Science and Discovery Centres (ASDC) have funded a two-year 'Science Capital in practice' national training programme, that offers funding to science centres nationally to embed the concept of science capital in their practice **(S7, S8)** to increase audience diversity and support inclusive practice. The ASDC's CEO says: '*Science Centres have included the concepts of Professor Louise Archer's Science Capital research in their STEM programmes and daily practice. The impact of these national programmes is significant. Overall, just three national programmes have reached millions*' **(S8)**. The work has had extensive impact on the thinking, delivery and strategy of science centres in the UK and internationally.

The key principles of the SCTA approach have been mainstreamed within the strategic plans of the Science Museum **(S9)**, IOP, Winchester Science Centre, the Ogden Trust, SEPnet and the Greater London Authority, to name a few. '*The research has informed policy and practice at the IOP and the principles of the SCTA have been integrated into our educational, policy and campaigning work with teachers and school aged children, helping to broaden engagement and participation in physics*' – Director of Education, IOP **(S3)**. STFC's 2019 Public Engagement Strategy bases its approach to 'reaching diverse communities' on SCTA principles and the SCTA has directly influenced one of their key programmes, The 'Wonder' initiative: '*Our growing Wonder initiative now supports over 20 projects across the UK that are focussing on engaging young people who reside within the 40% of postcodes identified as being subject to the most constrained economic circumstances. We know from meetings with project leaders that many are actively using the SCTA to inform how they approach this work*' – Head of Public Engagement and Skills, STFC **(S10)**. NESTA highlighted the SCTA in their 2018 project 'Shifting the dial on diversity in innovation' and invited Archer to present the work as one of five key ideas to help 'break the mould' 'to avoid having the same conversations year on year'.

In sum, the SCTA has led to significant changes in educational practice in schools and informal science learning settings both nationally and internationally, supporting more inclusive and engaging experiences of science for millions of young people.

5. Sources to corroborate the impact (indicative maximum of 10 references)

S1 Science capital research infographic.
S2 Testimonial from The Ogden Trust Chief Executive.
S3 Testimonial from The Institute of Physics Head of Education.
S4 Testimonial from Greater London Authority Education and Youth team.
S5 Primary Science Quality Mark.
S6 Testimonial from National Co-ordinating Centre for Public Engagement Director of Policy.
S7 Science Museum's Transforming Practice website on the Science Capital in Practice programme
S8 Testimonial from The Association for Science and Discovery Centres Chief Executive.
S9 Science Museum Group Strategic Plans.
S10 Testimonial from Science and Technology Facilities Council (STFC) Head of Public Engagement and Skills.