

Impact case study (REF3)

Institution: King's College London		
Unit of Assessment: 23 Education		
Title of case study: Using the concept of science capital to understand and build young people's science identities and aspirations		
Period when the underpinning research was undertaken: 2009 – 2017		
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	Professor of Sociology of Education	Nov 2005 – Feb 2017
Jonathan Osborne	Professor of Science Education	1985 – 2013
Jennifer DeWitt	Research Fellow in Science Education	2009 – 2014 2014 – Feb 2017 (part-time)
Heather King	Reader in Science Education	From 2010
Period when the claimed impact occurred: 2016 – 2020		
Is this case study continued from a case study submitted in 2014? N		

1. Summary of the impact

Despite targeted funding, participation in science-related study and extra-curricular activities in post-compulsory education remains patterned along gender, ethnicity and social class lines. To explain and better understand these patterns, researchers at King's College London proposed the concept of 'science capital' – an aggregate of one's science-related knowledge, attitudes, experiences and connections. The concept and associated research have provided the underpinning rationale for national governmental and third sector strategies aimed at supporting aspirations and public engagement in science, as well as informing national and international science assessment measures.

2. Underpinning research

The impact reported in this case study has been underpinned by a ten-year ESRC-funded programme of research led by Professor Louise Archer – the 'Young People's Career Aspirations in Science' studies (ASPIRES 1 and 2) [7,8]. The research followed a cohort of students in England from ages 10 to 19 in order to better understand the factors affecting the realisation, or otherwise, of their science-related aspirations and trajectories. It began at King's College London's School of Education, Communication and Society in 2009 and moved to the UCL Institute of Education in 2017.

The research in the ASPIRES projects comprised a series of cross-sectional quantitative surveys and in-depth qualitative interviews. The surveys were completed by a cohort of students in five phases spanning the period from when they were in their last year of primary school (Year 6) to when they were in the final year of compulsory education (Year 13). Each survey was nationally representative of the school population in England (although students participating in one survey had not necessarily completed a previous survey). For ASPIRES 1, over 19,000 surveys were completed: 9,319 by Year 6 students, 5,634 by Year 8 students and 4,600 by Year 9 students. For ASPIRES 2, a further 20,434 surveys were completed: 13,421 by Year 11 students and 7,013 by students in Year 13 or the equivalent. The qualitative interviews were conducted over the same five phases with a smaller group drawn from the same cohort of students. These enabled the researchers to track over 80 students and their parents in ASPIRES 1 as they moved from Year 6 to Year 9 and over 60 of these same students and their parents in ASPIRES 2 when they were in Year 11 and Year 13.

Impact case study (REF3)

The data showed that most young people reported liking and valuing science and that their parents valued science too. The data also showed that young people's aspirations were relatively consistent over time, but few aspired to become scientists [2]. Analyses further showed that aspirations and personal perceptions of one's ability in science are directly shaped by social class, gender and ethnicity [2]. For example, across all age groups, the students who were significantly more likely to express science aspirations and perceive themselves to be good at science came from socio-economically advantaged families. Boys were also significantly more likely to report wanting to study science in the future and to perceive themselves as being good at science. By contrast, girls were less likely to aspire to study science in the future, and more likely to state that they were not good at science and that they did not see themselves as 'sciencey'. Ethnicity was also found to be significant in determining the likelihood of young people having science-related aspirations, with Black students overwhelmingly seeing the careers of scientist or science teacher as 'not for me' despite being interested in science [3]. Irrespective of class, gender and ethnicity, students with a family member with a science qualification and/or science-related job were significantly more likely to have science-related aspirations and to perceive themselves as good at science. The intersectionality of contributing factors produces a complex picture: Asian male students with a family member working in science were found to be most likely to have science-related educational and career aspirations. Conversely, students found to be least likely to aspire to a science-related future tended to be white and female with no family members working in science-related fields [1,2,3,4].

To explain these varied patterns in science aspirations and perceptions, Archer and her team proposed the concept of science capital [4]. Science capital encapsulates all the science-related knowledge, attitudes, experiences and connections that an individual acquires and builds throughout their life. It equates to what you know about science, how you think about science, what you do that is science-related and who you know who works in or engages with science. Inspired by the work of sociologist Pierre Bourdieu on the role that different forms of capital play in the inter-generational reproduction of social and economic advantage, the concept of science capital was developed to direct attention to wider structural factors affecting a young person's opportunities to access science, and to provide an explanation for disengagement that does not rest on a deficit construction of young people as simply lacking interest.

The concept was tested empirically by comparing the ability of the science capital construct to predict science aspirations-related outcomes against a measure of cultural capital [5]. Science capital was found to be the better predictor. The concept and its application to educational contexts was also tested in practice by working in partnership with teachers and museum education practitioners in a follow-up project ('Enterprising Science', 2012–2017 [9]). The findings of this project [6] highlighted the constituent components of the science capital construct that educators found clear and less clear, and identified effective pedagogical practices for building science capital, such as involving families in science learning experiences and promoting the broad possibilities of science-related futures.

The concept of science capital developed and refined by Archer and colleagues provides the field of science engagement with an analytic tool that both explains and illuminates why some students feel able to participate in science-related activities and study while others do not. Their research findings have additionally shown the importance of building a science identity from a young age and confirmed the importance of how a student's ability to 'get on' in life is shaped by the diverse resources they acquire from home, community and school.

3. References to the research

- [1] Archer, L., DeWitt, J., Osborne, J. F., Dillon, J. S., Wong, B. & Willis, B. (2013). *ASPIRES Report: Young people's science and career aspirations, age 10–14*. London: King's College London.
- [2] Archer, L., DeWitt, J. & Wong, W. (2013). Spheres of influence: What shapes young people's aspirations at age 12/13 and what are the implications for education policy? *Journal of Education Policy*, 29(1), 58-85. DOI:10.1080/02680939.2013.790079.

Impact case study (REF3)

- [3] Archer, L., DeWitt, J. & Osborne, J. (2015). Is science for us? Black students' and parents' views of science and science careers. *Science Education*, 99(2), 199-237. DOI:10.1002/sce.21146
- [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. DOI:10.1002/tea.21227
- [5] DeWitt, J., Archer, L. & Mau, A. (2016). Dimensions of science capital: exploring its potential for understanding students' science participation. *International Journal of Science Education*, 38(16), 2431-2449. DOI:10.1080/09500693.2016.1248520
- [6] King, H., Nomikou, E., Archer, L. & Regan, E. (2015). 'Teachers' understanding and operationalisation of 'Science Capital'. *International Journal of Science Education*, 37(18), 2987-3014. DOI:10.1080/09500693.2015.1119331

Funding

- [7] Osborne, J., Archer, L. (2009-2013). Science aspiration and career choice: age 10-14 (ASPIRES 1). Economic and Social Research Council (ESRC): GBP745,592.
- [8] Archer, L., DeWitt, J., Francis, B., Osborne, J. (2014-2019). Young People's Science and Career Aspirations age 14-19 (ASPIRES 2). ESRC: GBP842,092.
- [9] Archer, L., Dillon, J., (2012-2017). Enterprising Science Programme. BP Chemicals Ltd: GBP1,600,088.

4. Details of the impact

The concept of science capital and the detailed findings from the ASPIRES research have formed the bedrock for the design and implementation of new policies, initiatives and assessments aimed at widening participation, which recognise the importance of building learners' science identities from an early age and the role played by families and schools in forming young people's science-related aspirations.

Science identity and science capital at the heart of international and national assessments

On the international stage, ASPIRES research has had a direct impact on how the OECD's Programme for International Student Assessment (PISA) evaluates science education. PISA, implemented every three years, assesses 15-year-olds' performance in the fields of reading, mathematics and science. The results are widely reported and debated in the media and often used as a measure of a country's educational success. Science capital is listed as a key indicator in the new 'Scientific Identity' dimension that is being introduced as part of PISA 2024. This new dimension reflects the extensive evidence linking identity to science learning and attainment and is identified as "an important and urgent priority" in the *PISA 2024 Strategic Vision and Direction for Science* report [A p.12]. The report further states that science capital "plays a key role in shaping the extent to which a young person experiences science as being 'for me' or not, and significantly relates to post-16 science aspirations and progression." [A p.14]. 79 countries currently participate in PISA and many shape their curricula in response to its specific dimensions.

Domestically, ASPIRES findings have impacted assessment practices in primary schools across England with science capital now a key criterion in the Ofsted-endorsed Primary Science Quality Mark (PSQM) [B1]. This national award scheme recognises schools that demonstrate effective and confident science leadership and is delivered as a year-long teacher professional development programme. Clare Warren, a senior PSQM leader, reported that "*Science capital is an important concept for primary schools to consider, because children aged 10 with low science capital, who also expressed no interest in STEM careers, were very unlikely to have changed their minds by the age of 14. It is for this very reason that, when the PSQM criteria were amended in 2017, the new criterion, 'L3: There is a commitment to developing all children's science capital', was incorporated*" [B2 p.22]. The criterion assesses the ways in which schools build children's science capital through extended outreach work with parents and involving children in extracurricular activities. The PSQM impacts 240,000 children and 9,000 teachers annually.

Influencing strategic plans aimed at building young people's science aspirations

Insights from ASPIRES findings regarding the social factors shaping young people's participation in science, and the root causes of disengagement, have directly influenced governmental strategies for diversifying and widening participation in science education and careers. In England, the 2017 House of Commons Science and Technology Committee's report on 'Science Communication and Engagement' was commissioned to enhance engagement with the public on funding, policy and future research directions in science. The report draws on the concept of science capital to frame its discussion on the opportunities for promoting greater science awareness in the public sphere [C1 p.3,9,10,11,26]. The report was informed by evidence submitted by the National Forum for Public Engagement in STEM (a collective of key funders and organisations involved in setting the agenda for public engagement in STEM nationally). The Forum's evidence highlighted the significant contribution of ASPIRES research findings in focusing their member organisations' attention on the ways in which children's science identities are formed and how, for some children, intersectional factors combine with the result that science careers are seen as 'not for me' [C2 p.5,7].

ASPIRES research findings relating to socio-economic disadvantages were used in the 2017 Scottish Government's STEM Strategy to frame the broad societal challenges that need to be overcome to widen participation in STEM education and careers in Scotland. The Strategy referenced the ASPIRES research as part of its 'Evidence Base' [D p.17], in particular its identification of the role that 'key influencers' (ie teachers and parents) play in promoting science careers awareness and the need for STEM-related subjects to be promoted across all school ages. The social contexts in which science capital is acquired and built are also noted in the 2019 Scottish Parliament's inquiry into 'STEM in early years education' [E1 p.3]. The report of the inquiry highlights correlations between the inclusion of STEM education in the early years curriculum and children's continued competence and interest in STEM into adulthood, noting the importance of STEM education in the early years for children who are socio-economically disadvantaged and/or have limited access to STEM capital in the home. This inquiry prompted the subsequent creation of a new online module for early learning and childcare staff across Scotland to help them inspire young children in science and maths [E2].

Refocusing outreach and engagement programmes

National organisations, science museums, learned societies and charities have used the concept of science capital, and the findings of associated research on how it can best be built, to direct their engagement and outreach activities. For example, the Institute of Physics – the professional body and learned society for physics in the UK and Ireland – used the research to refocus its programming upon families with primary-aged children. The Public Programmes Manager at the Institute states that, *"The work of the ASPIRES project, and particularly the definition of Science Capital, has been invaluable in guiding and shaping the family outreach and public engagement work done by the Institute of Physics. A key pillar of the IOP's work is in raising public awareness and appreciation of science in everyday life and how science is addressing the challenges facing society. In response to the ASPIRES findings, the focus for outreach and engagement activities are families with KS1/KS2 children to try and reach them at a time when we could have the most impact. Our approach is to engage the whole family, with follow-on activities and resources for the home, to support families to have conversations about the relevance of science, empowering them to gradually build their own science capital"* [F].

The British Science Association (BSA), the learned society founded in 1831 to aid the promotion and development of science, has similarly used ASPIRES findings to change its public engagement priorities. The Chief Executive of the BSA notes, *"The ASPIRES findings showed very clearly that our [previous] approach was flawed: most children had already decided they did not want to 'be' a scientist by the time they finished primary school. We decided to prioritise primary-aged children instead of secondary-aged children and switched the majority of our education programme resources to our under-developed primary CREST scheme instead. Since 2016, we have reached over 50,000 primary school children directly, and many more indirectly. We brought many of our CREST partners and stakeholders with us on this journey and the ASPIRES 'killer slide' [1, figure 2, p.2] was part of our standard presentation template during this period, to explain the rationale behind our change of strategy"* [G].

Impact case study (REF3)

Changing the direction of organisations' thinking

ASPIRES research findings have been used by organisations to underpin their strategic objectives. For example, the Science Museum Group has described its commitment to growing the science capital of their audiences as a core priority, stating, “*We use the principles of science capital to shape all science engagement experiences... our organising principle is to build science capital to enrich people’s lives and enhance their contributions to society*” [H p.16]. The BSA, meanwhile, acknowledges that the research has changed the very working practices of their organisation. Its Chief Executive explains that “*the work of Professor Archer and her team has helped us understand that the BSA itself needs to change, if we are to succeed in our goal of enabling more people to develop a stronger ‘science identity’. This led to us putting equality, diversity and inclusion at the heart of our mission. We recognise that we are part of the field and therefore we need to change. We have committed to improving the diversity and inclusivity of our workforce. We have invested in our own audience analysis to better understand how the most under-served communities relate to science... [ASPIRES research] has had a significant effect on our work and our approach, and I believe it will continue to do so for many years*” [G].

The impact of the ASPIRES research programme continues to grow. The research has been awarded the British Educational Research Association Public Engagement and Impact Award in 2018, was a finalist in the ESRC Outstanding Societal Impact prize of 2019 and has seeded subsequent studies and initiatives nationally and internationally. The Impact Case Study submitted by the UCL Institute of Education further describes the impact of research which utilises the concept of science capital to guide more equitable science engagement initiatives.

5. Sources to corroborate the impact

- [A] Organisation for Economic Co-operation and Development (OECD) (2020) *PISA 2024 Strategic Vision and Direction for Science*.
- [B] Documents associated with Primary Science Quality Mark: [B1] Primary Science Quality Mark (PSQM) Awards Criteria and descriptors; [B2] Association for Science Education (ASE) (2019) *Primary Science Special Issue: Primary Science Quality Mark (PSQM)*.
- [C] Documents associated with House of Commons Science and Technology Committee’s report on ‘Science Communication and Engagement: [C1] House of Commons Science and Technology Committee (2017) *Science communication and engagement: Eleventh Report of Session 2016-17 (HC162)*; [C2] Written evidence submitted to the House of Commons Science and Technology Committee by the National Forum for Public Engagement in STEM.
- [D] Scottish Government (2017) *Science, Technology, Engineering and Mathematics (STEM): education and training strategy*.
- [E] Documents associated with Scottish Parliament’s inquiry into ‘STEM in early years education’: [E1] Scottish Government (2019) *Education and Skills Committee: STEM experiences in early years education. Submission from Education Scotland*; [E2] Scottish Government (2020) *Learning in STEM in early years* [press release].
- [F] Testimonial from: Public Programmes Manager, Institute of Physics (IOP), 23 October 2019.
- [G] Testimonial from: Chief Executive, British Science Association, 18 February 2021.
- [H] Science Museum Group (2020) *Inspiring Futures: Strategic Priorities 2017-2030*.