Young people, science, engagement & participation: a 'science capital' approach

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E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

ASPIRES 2
science and career aspirations: age 10-19

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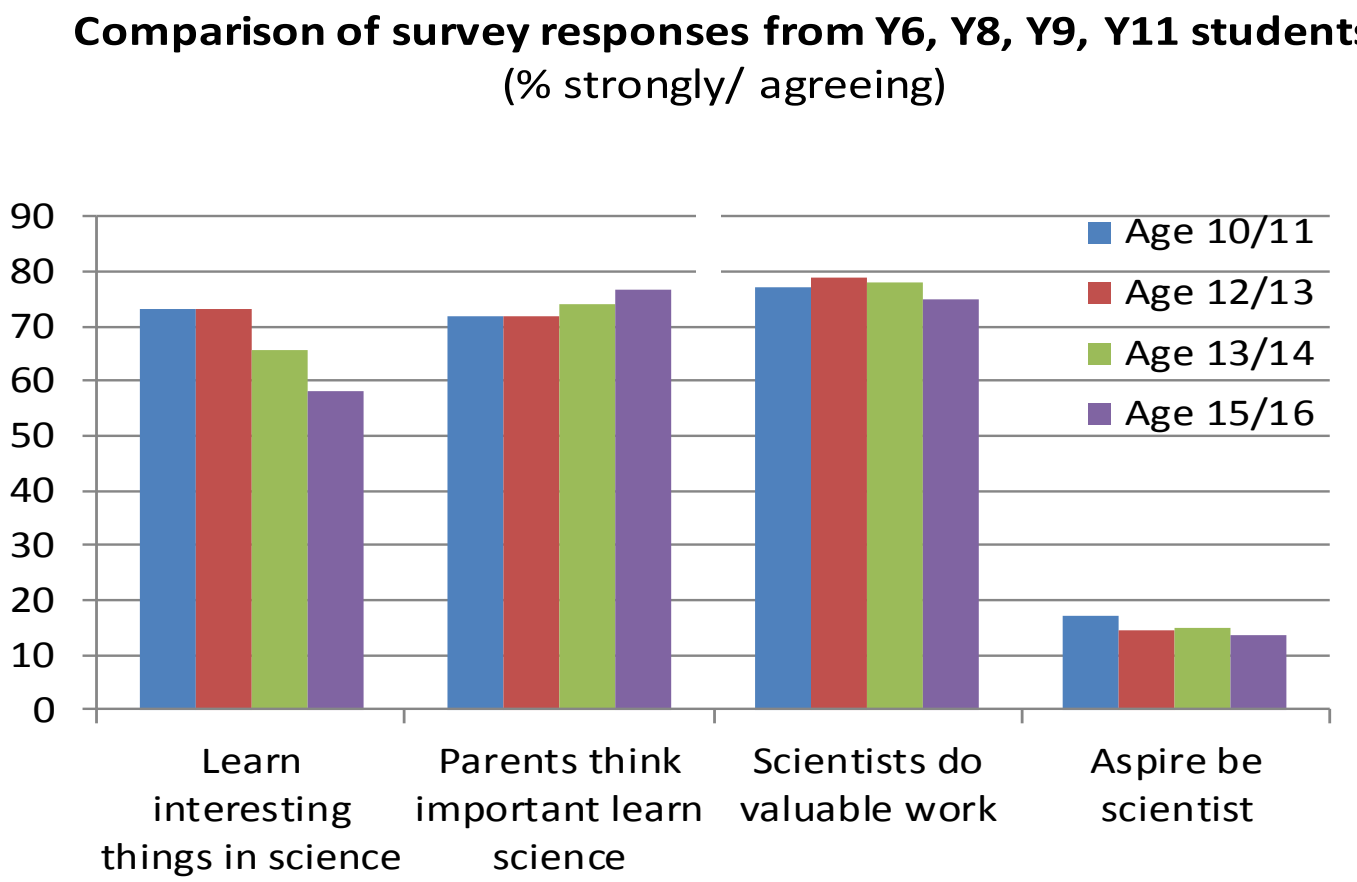
The Policy Context: the science participation 'problem'

- Lots of time and money has been invested in efforts designed to engage more young people with science
- But there has been little or no change in participation rates (and in the profile of those who continue with science post-16)
- Many efforts have sought to make science more 'fun' and 'interesting
- But our research suggests that a lack of interest in science is not the problem!

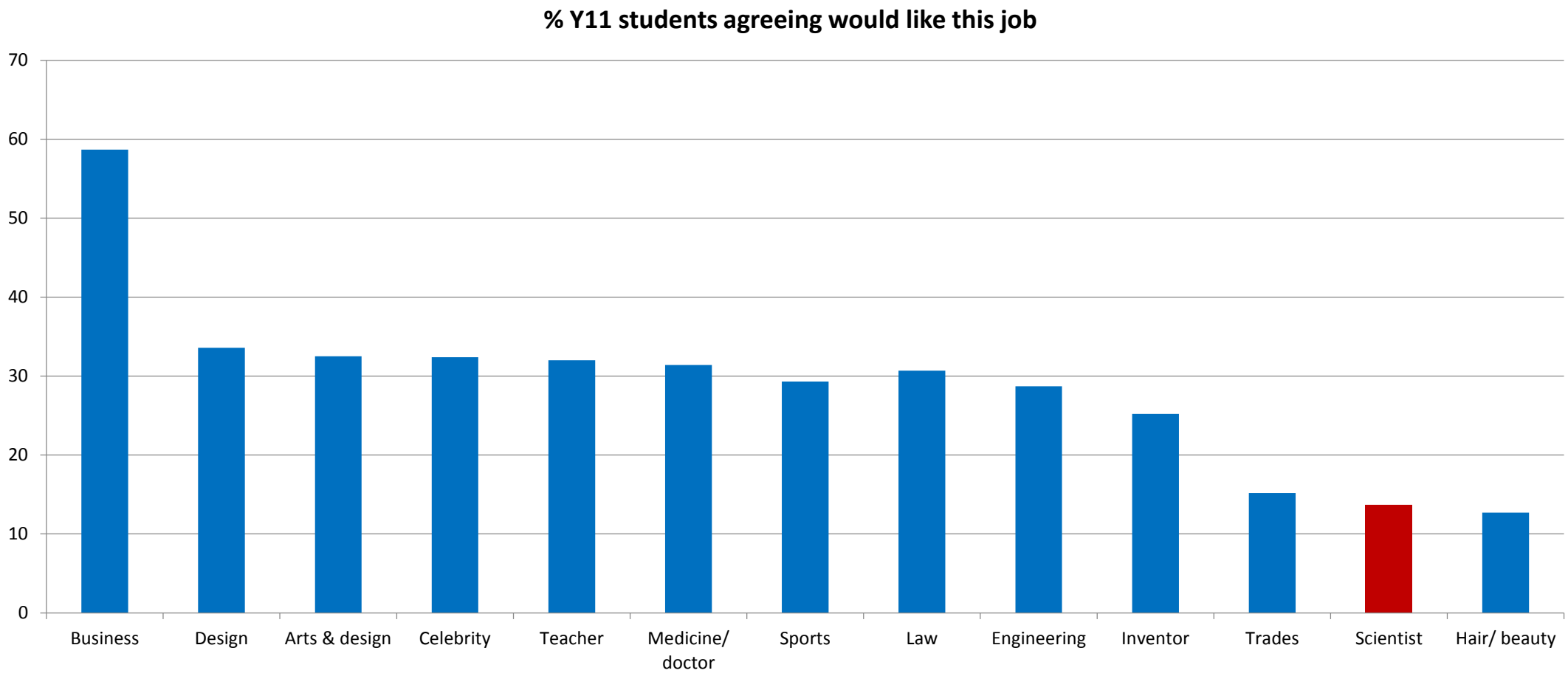
Aspires/ Aspires2 research

- Since 2009 the ASPIRES project has undertaken large-scale surveys (31,000+ young people to date), and in-depth tracking of students and their parents (age 10-16)
- ASPIRES/ ASPIRES2 project: www.kcl.ac.uk/aspires

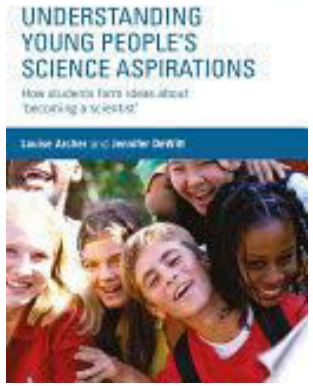
Most students like science - but few aspire to be scientists



What careers do students aspire to?

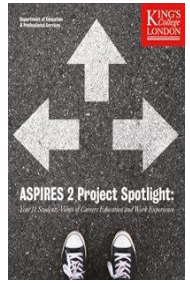


What shapes these patterns?



Aspires/ Aspires2 identifies many factors, working in combination:

- **Gender**: 'masculinity' of science; lack of fit with popular femininity; muscular intellect, stereotyping and lack of encouragement from others, boys silencing girls, 'brainy' image of science, arts/science divide; school type)
- **Ethnicity**: community/ family discourses; racisms in science; intersection of ethnicity, class and gender stereotypes; 'brainy' image of science
- **Careers education** (e.g. girls, minority ethnic, lower set etc students all report receiving significantly less careers information)
- **School/ education system structures**: stratification of KS4 science ('Double' and 'Triple'; A levels system of early specialisation; grade severity in Physics)
- **'Science capital'**



A Boudieusian lens on science participation

- Interactions of *habitus*, *capital* and *field* produce patterns in science engagement and participation:
- ***Habitus***: socialised, embodied layers of dispositions which shape whether science is experienced as 'for me', or not. Dispositions are formed through classed, gendered and racialized experiences and positionings. Gives a 'feel for the game'
- ***Capital*** – cultural, social economic and symbolic resources possessed and accrued (the 'hand' you can play in the game) – structured by social axes
- ***Field*** – socially/historically constructed socio-spatial arena, sets the 'rules' of the game; differential, relational positioning of actors (a 'space of positions and position-taking'). Dominant social institutions (e.g. education systems, schools) 'work' to filter students and reproduce dominant social relations
- Extent of 'fit' between habitus, capital and field shapes whether students experience (science) education as a 'fish in water', or not

Habitus and science participation

- Is science for ‘people like me’, or not?
- Family habitus – how different families make science im/possible & un/desirable (e.g. ‘science families’ versus ‘science as absent/peripheral’)
  - “The other day in the car we were laughing about chemical symbols and things, so I guess it does come into the discussion quite subliminally really” (Mother).
- Some (classed, gendered etc) habitus ‘fits’ better with the field of science education and produces science-related dispositions.
  - E.g. Middle-class masculine habitus may lend more easily to performances of ‘muscular intellect’ that are valued in dominant science spaces
- Shapes whether science is ‘who we are’ or peripheral/ absent to daily life and identity

  “Science is just where it’s at in my family” (Davina)

  “I suppose in everyday life you don’t get that much to do with it [science]” (Mother)

  “They never talk about science” (Jack)

  “I’m not clever enough” to do science (Danielle)

Capital and science participation

- Capital = resources (cultural, social, economic and symbolic)
- The more you have of the 'right sort' of capital (the type recognised and valued by the field), the more you are able to 'get on' in/ with science
- Families with more of the most-valued, high-status/recognised ('symbolic') forms of capital are more likely to 'get on' in the science 'game'
- Example, 'Robert M':
  - Has "lost track" of how many science museums/ centres has visited
  - Family 'New Scientist' subscription; Parents "like science a lot"; family watch science TV together & talk about science news stories
  - Construction toys and opportunities at home; Dad's workshop – he and Robert love 'making things'; home experimenting (" I mix champagne, vinegar and baking soda and try to fire a cork")
  - Member of Air Society (does engineering challenges, flying model planes, etc)
  - Family friends are engineers; Robert's friends are all into science

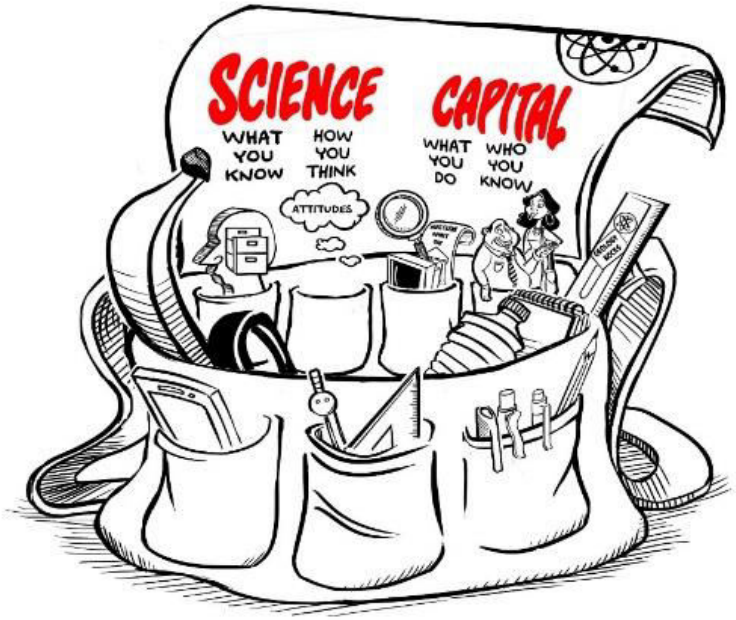
But Bourdieu did not really engage with the science aspect!

- Bourdieu and cultural capital: Arts-based, aesthetic dispositions, 'taste'; Emphasis on 'high' culture ('*les beaux arts*')
- Bourdieu's is an historic formulation:

  'Given the scale of technological and social change, it would be remarkable if Bourdieu's account of cultural capital continued to exist in an unchanged form' (Prieur & Savage 2013, p.249).
- We have extended the concept to address scientific forms of capital (Archer et al. 2015)
- In particular – seeking to identify which configurations of science-related cultural and social capital have the most symbolic/ exchange value

Science capital

- Developed in Aspires project and extended in Enterprising Science project
- ‘Science capital’ is a ‘conceptual holdall’, combining habitus, cultural and social forms of capital



Where does ‘science capital’ come from?

- Socialised layers of disposition and resources from home and schooling (habitus and capital aspects) – attitudes, values and practices
- How much, and what sort of, science capital you have will be shaped by home, school and everyday contexts (field)
- Within any given field, the most powerful forms of capital will be those whose intrinsic value can be most readily and precisely converted into symbolic forms that match the requirements of the field.
  - ‘‘Capital does not exist and function except in relation to a field’’ (Bourdieu & Wacquant 1992, p. 101)
  - Process of legitimation of capital - rather than the actual content or form of the capital itself - is key to the production of advantage/ privilege (Skeggs 2004)

Analogy

ENGAGEMENT & PARTICIPATION – burning flame - what is produced at the interface of habitus, capital and field

FIELD – air and conditions around the candle (e.g. gas content, wind) will influence if and how the candle burns (e.g. how bright, how long, flickering or steady)
Whether and what sort of 'heat' is provided (e.g. from educators, experiences, ISL settings)

HABITUS & CAPITAL – the marbled candle combines students socialised dispositions, and (science-related) economic, social and cultural resources – all shaped by social class, ethnicity and gender

Interaction of h,c and field shape how science is experienced ('for me'), whether capital is leveraged, and what identity work students can 'do'

- But which types of science capital are the most useful? And in our case, which have the strongest relationship to science identity and to post-16 progression?

‘Measuring’ science capital

Developing an index of science capital

- Combination of original and pre-existing instruments
  - E.g. ASPIRES; Bourdieu 1984; Public Attitudes to Science survey (2011); ONS 2002
- Piloting (11-15 year olds)
  - 1,463 students, 2013
  - 6,000+ students, 2013 (project schools)
- National survey
  - 3,658 11-15 year olds, 2014

Main dimensions or ‘types’ of science capital

1. Science literacy (science knowledge and understanding)
2. Science-related attitudes and values

   a) Seeing science as everywhere in daily life;

   b) Understanding the wide value and uses of science – e.g. seeing science qualifications as useful for a wide range of non-science, as well as science, jobs
3. Out of school science behaviours:

   a) Reading and engaging with science through the media (books, magazines, TV, internet etc) in your spare time;

   b) Going to science museums, centres, talks, events

   c) How often talk to other people about science in everyday life
4. Science at home:

   a) Family science qualifications, knowledge and skills

   b) Knowing people in science-related jobs

   c) Encouragement from others to continue with science post-16

- Findings (national survey of 3,658 11-15 year olds in England):
    - 5% have ‘high’ science capital
    - 68% have medium levels of science capital
    - 27% have low science capital

Who has science capital? Social patterns

- Gender – Boys had significantly higher means on the science capital variable (44.39) than girls (43.04) ($p<0.01$) and are over-represented in the 'high' science capital group
- Ethnicity – South Asian students score higher than White and African/Caribbean
- Cultural capital – 'middle class' score higher
- School set – top set students score highest and lower sets score lowest. BUT students in schools which do not set for science have high science capital scores (same as top set)

Relationship between science capital and science aspirations

- Percentage of students agreeing ‘I would like to study a science subject at University’:

High science capital:	50%
Medium science capital:	20%
Low science capital:	6%

Science capital and science identity

- Percentage of students agreeing ‘Other people think of me as a science person’:
  - High science capital: 80%
  - Medium science capital: 23%
  - Low science capital: 3%

A ‘science capital’ pedagogical approach

Enterprising Science project

- Five year R+D project (KCL, Science Museum, BP)
- Focus on data from 2015/16 – professional development/ intervention strand
- 2015/ 16: worked with 9 secondary science teachers (6 London schools)
- 'Science capital' pedagogical approach (utilising a 'funds of knowledge' and Bourdieusian inspired 'science capital' approach, Archer et al., 2015) – equity orientated praxis
  - 9 month 'ethnographic' classroom observations of 9 London classes
  - 13 discussion groups with 59 students
  - 2 teacher workshops
  - Pre/post teacher interviews
  - Pre/post science capital surveys with students

Basic tenets of our ‘science capital approach’

- Change the field – rather than the student
- Work from what students bring with them – *personalised* and *localised* (rather than just contextualised) learning

  ‘When a child’s worldview is left unvalued and expressionless in an educational setting, what should we expect in terms of engagement, investment and learning from that child?’ (Calabrese Barton et al., 2011, p.5)
- Actively cultivate/ develop key dimensions of science capital
- Challenge stereotypes and dominant ideas/ representations of science, ‘who does science’ and what constitutes ‘doing science’

What did we find?

- Focus on qual evidence (observations, teacher pre/post interviews and student discussion groups)
- Careful with survey evidence as:
  - Sample too small
  - Some issues with wording that need tweaking

Changes in practice

- Observations, interviews and discussion groups show changes in practice
- “That’s been a best part, you know - it really has changed how I teach”. Ms Smith
- I knew that there’s something to this, that there is something that is of value. Because you know sometimes with some research it’s a lot of … it’s all well and good in theory, but in practice it doesn’t always work. So with this when I could see that actually the theory put into practice there is something to it. I thought okay just persevere, keep going with it (Ms. de Luca)

- Students agree that also notice consistent changes in practice in line with the approach (“going off topic”)
  - “she teaches you based on what you know”; “like she's linking it [science] to jobs that we can have, that was quite interesting”.
  - Pre/Post surveys show increase in percentage agreeing (and decrease in percentage disagreeing) ‘my teachers explain how science qualifications can lead to different jobs’

Increased interest and enjoyment of lessons

- Positive changes in pre/post surveys on item ‘I learn interesting things in science lessons’
- Observation data plus teacher and student data suggests perceived increases in interest and enjoyment of lessons. Eg.
- “I think they’re much more engaged with the science”, Ms. Arkwright
- “It makes the lessons fun” (Tanisha, Mr Hobbes class)
- “I think that makes the lessons more lively” (Fawaad, Ms. Arkwright Class)

Increased attention and motivation

- Positive changes in pre/post surveys on item ‘I pay attention in science lessons’
- Observation, student and teacher data examples:
  - “So [Y10 bottom set] are a very challenging group of students […] Through the year what I’ve noticed is when [I use the approach] I can see it their eyes … they kind of … like a meerkat, they pop up and you can see the engagement and you can see that they talk about it a bit more. (Ms. de Luca)
- ‘Meercat moments’ – reduction in dissonance between habitus and field?
  - The big difference has been their engagement and their interaction with the lesson… especially if kids can talk about their experience, express themselves or their ideas – I find they’re far more engaged and they value it a lot more.[…] When they’re talking about something you can see they’re happy, they’re excited. When they do tasks, they want to get it done and they want to tell everybody what they’ve discovered or their answer, or what poster they’ve made. So they’re eager to share, they’re eager to show (Mr Okello).

Increased student understanding

- Positive changes pre/post survey on item ‘I know how to use scientific evidence to make an argument’
- Observation, teacher and student data examples suggest makes more meaningful and memorable (“it stays in our head even more”):
- Yeah I think it has increased their understanding. Like with the lesson today, like I wouldn’t be able to repeat things that I’ve taught before to them because it would be like ‘Huh? I don’t actually understand this’. (Mr Hobbes)
- “Yeah, it’s a better way to make us remember things. Like it’s not like a boring way of like just reading and then trying to get it into our heads” (Tahir, Ms. Enoh’s class)
- So it kind of like lets us relate to what she's actually talking about … so we can understand it more […] If you relate it to what we’re doing, you just get the concept quicker. (Rohan, Ms. Randel’s class)
- I think it’s like quite cool, 'cos then you like think about it and then you're like, ‘oh yeah, that’s related to like everyday life’ and you're like, ‘I’ll remember that now’ and you shall remember it. (Christopher, Mr. Okello’s class)
- Yeah, I feel like we get a better understanding because we can relate to what she's teaching us (Alfie, Ms. Arkwright’s class)

Attainment – mixed views

- It has been better than the target, they've been given like D to E targets but now I'm expecting at least 50% of the class grade C […] I think it did have some impact because we started off expecting, you know, very poor grades from this group, and I'm really surprised that they have done extremely well over the year when I looked at their overall result … much better than we've actually predicted (Ms. Dennis)
- The way we assess students with our summative tests, I think science capital doesn't necessarily make them better at that, but it does increase engagement … those tests cater best for kids who can retain a lot of information and grind through a lot of data just before their exam or the test, and I don't think [they] necessarily reflect or show some of the more important skills that we'd like [students] to develop (Mr Okello)

Changing dispositions?

- Pre/post surveys ‘science skills are useful for lots of future jobs’ – but not all items
- Most teachers and students report changes:
- So some kids got engaged with science. Some of them told me at the start of the year that ‘oh, we didn’t learn anything last year, we are not even sure why we’re doing Science’ … da-da-da. So at the start of the year I found some of the attitude like really difficult to deal with because some of them did not care. But as the year progressed they started picking up and some of them actually started showing some interest, yeah. […] some of them told me ‘oh miss, we’re really starting to enjoy Science now’ […] I mean the progress that I’ve seen with some of them is … I think that’s the biggest achievement. (Ms. Enoh)
- I think it’s more like interesting because you have an idea of where it might come up in your daily lives, whereas in other Science lessons or like in the past, when someone said something, you're like, oh, it’s just that, like it won't come to your use. (Shona, Ms Arkwright’s class)

Changes in out of school practices?

- Small and patchy evidence
- Some teachers see an increase in home discussions:
- [They] definitely felt a relevance of what I teaching them to, you know, decisions that their parents had made … [for example] why you shouldn't just use antibiotics all the time. That worked really well. I really do think most of them did have a conversation round the dinner table, you know, yeah … that was really good.
- A couple of students report changes in behaviours
  - E.g going to buy a TV; mobile phone use at home; watching Ted talks
  - "We actually use it [science] in our lives. Compared to other teachers, they just tell us, that's it, we move on, whereas [Ms Arkwright] tells us and then we actually learn from it and implement it in our lives". (Brody)

More inclusive participation

- No comparable survey item (added for 2016/17). Observed across all schools. Teachers and students agree helps more students contribute to lessons
- “Yeah, it definitely … for the boys who didn’t want to really talk in class … that did work. For the boys that got sort of enveloped by other boys” (Ms. Smith)
- “Generally I think I get overall more participation purely because of science capital, that’s what I personally feel […] Since I’ve started using science capital they’ve been able to engage far more in lessons than they normally would” (Mr Okello)
- “[It is] more of a friendly environment” (Fawaad)
- If she’s [teacher] explaining something she’ll give like an example that everyone could relate to, and everyone’s like ‘Oh yeah’. And then they’ll say something, then someone else will say something. And then quite a few people have something to say. And then it’s like ‘Oh yeah, so we’ve experienced it’ so yeah.” (Daniel)
- “Cos like it brings everyone together, like, everyone has like something to say, instead of it just being like one or two people that know the answer”

Happier teachers!

- “It’s making me happier, as a teacher” (Mr Hobbes)
- Provides a framework for ‘meaningful’ teaching and push back against performativity
  - “KS4 is where you lose the kids from science” (Ms Dennis)
  - “’Is this in the test?’ is the most annoying and hurtful thing you can hear from a student” (Mr Hobbes)
- Shifts among some teachers’ colleagues – from scepticism/ hostility to sharing/ interest and requests to cascade

But it is not perfect! Challenging views & issues

- Enactment of the approach was varied and takes time – still a developing process
- Difficulty of balancing with demands of performativity, esp. at KS4
- A few students were less keen/ sceptical:
  - Like, half I like it and then half maybe it's a bit of a waste of time […] I think we miss a lot of the lesson, so most of the time, if he does say his stories, it will take about .. about 20 minutes, something like that, so it kind of takes a lot of time […] but I quite like it at the same time (Joya, Mr Sharma's class)
- No overall changes in student science capital on pre/post surveys
- Some item trends going the wrong way! (e.g. 'I arrive on time for science lessons')

Reflection on the pilot approach

- ‘Hope … does not consist in crossing one’s arms and waiting’ (Freire 1970, p.73).
- Value in seeking small gains alongside ‘longer term’ goals
- Not over-claiming – small scale and exploratory pilot
- But does feel promising
- Expanding in northern schools in 2016/17, in partnership with National STEM Learning Centre

Further Implications for education

- Shift policy discourse – interest is not enough
- Rather, focus on building science capital
- Focus on changing the field (not young people!)
  - E.g. Science capital pedagogical approach
  - Address inequalities and issues in careers provision (more, better, earlier, monitored uptake)
  - Focus on systemic barriers (e.g. double/triple, etc)
- More complex & nuanced understandings of inequality – and support for educators to engage with these
- Importance of spaces for professional reflection and support to take 'risks'

Recent Project publications – Aspires2

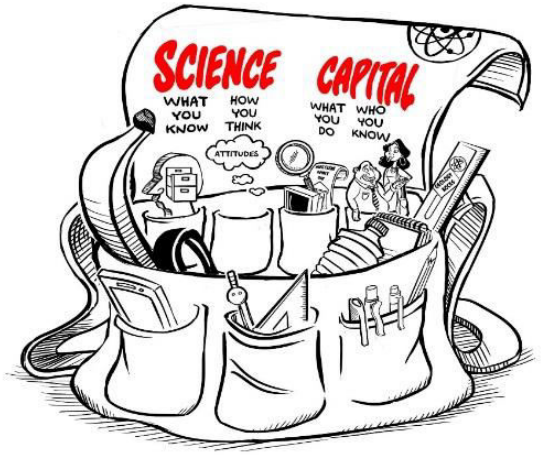
- Archer, L. & DeWitt, J. (2016) *Understanding Young People's Science Aspirations*. London, Routledge
- Archer, L., Moote, J., Francis, B., DeWitt, J. & Yeomans, L. (2016). The 'exceptional' physics/ engineering girl: a sociological analysis of longitudinal data from girls aged 10-16 to explore gendered patterns of post-16 participation. *American Educational Research Journal*
- Archer, L., Moote, J., Francis, B., DeWitt, J. & Yeomans, L. (2016). Stratifying science: a Bourdieusian analysis of student views and experiences of school selective practices in relation to 'Triple Science' at KS4 in England. *Research Papers in Education*
- Francis, B., Archer, L., Moote, J., DeWitt, J. (2016) Perceptions of gender issues in access to Physics: the construction of Physics as a quintessentially masculine subject. *Sex Roles*
- Francis, B., Archer, L, Moote, J. & MacLeod, E. (in press) Femininity, science, and the denigration of the Girly Girl. *British Journal of Sociology of Education.*
- Moote, J. & Archer, L. (in press) Failing to Deliver? Exploring the current status of career education provision in England. *Research Papers in Education*.

Project publications – Enterprising Science

- Archer, L., et al. (2016) "I'm gonna be a man here": Performances of masculinity and engagement with science during a school/museum intervention. *Journal of the Learning Sciences*
- Archer, L., et al (2016) Disorientating, fun or meaningful? Disadvantaged families' experiences of a science museum visit. *Cultural Studies of Science Education.* Published on iFirst, DOI 10.1007/s11422-015-9667-7.
- Archer, L., et al (2015) Science capital: a conceptual, methodological, and empirical argument for extending Bourdieusian notions of capital beyond the arts. *Journal of Research in Science Teaching,* buff.ly/1LNleLK.
- Archer, L. et al. (2015) Author Response. Science Education 99(6): 1147-1149.
- Archer, L. et al (*under review*) Putting Bourdieu to work in the classroom: developing a 'science capital' pedagogical approach with teachers and students. *British Journal of Sociology of Education*.
- Archer, L. et al. (*under review*) 'Killing curiosity'? An analysis of celebrated identity performances among teachers and students in nine London Secondary Science Classrooms. *Science Education.*
- Archer, L. et al. (*under review*) Can The Subaltern Do Science? Intersections of Gender and Ethnicity Within Minoritized Students' Struggles For Intelligibility and 'Voice' In The Secondary Science Classroom. *Journal of Research in Science Teaching.*
- DeWitt et al (in press) Dimensions of Science Capital: Exploring the potential of the concept of science capital for understanding students' science participation
- King, H., Nomikou, E. Archer, L. & Regan, E. (2015) Teachers' Understanding and Operationalization of 'Science Capital'. *International Journal of Science Education,* 37(18):2987-3014.

More info: videos, summaries, animation

- 2 minute animation ‘what is science capital?’: buff.ly/1FmfXsi
- Science capital made clear publication: buff.ly/1XerGPE
- Teacher films: http://www.kcl.ac.uk/sspp/departments/educati…/research/Research-Centres/cppr/Research/currentpro/Enterprisin…Capital-in-the-Classroom.aspx
- Selection of short talks and research briefs on ou… www.kcl.ac.uk/enterprisingscience
- TedX talk **https://www.youtube.com/watch?v=g…**



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- ASPIRES/ ASPIRES2 project: www.kcl.ac.uk/aspires
- Enterprising Science project: www.kcl.ac.uk/enterprisingscience

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science and career aspirations: age 10-19

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