Interplays of identity and capital in shaping young people's STEM trajectories: Insights from the ASPIRES project

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The challenge for equity and inclusion in STEM

- Ongoing domination of science/**STEM by privileged people** (e.g. White, male, middle-class, able-bodied, etc.) – especially in engineering, physics and computing

- Existing efforts are often **deficit**-based, e.g.
  - Trying to change young people, treating them as 'lacking'
  - Education gap vs. education debt? (Ladson Billings 2006)

- Our research suggests that (i) lack of interest and motivation is not the main issue and (ii) educational settings and practices play a role in excluding and dissuading students from science/ STEM

ASPIRES 2
Executive Summary
Young people's science
and career aspirations,
age 10–19

ASPIRES project

- ESRC funded, since 2009, tracked a cohort of young people from age 10-23

- Mixed methods – surveys of young people and longitudinal interviews with children and parents

- Six data collection time points

Design

Age	Surveys (47,622 total)	Interviews (765 total)
Age 10-11	9,319 students (279 primary schools, England)	92 children, 84 parents
Age 12-13	5,634 students	85 students
Age 13-14	4,600 students	83 students, 73 parents
Age 15-16	13,421 students	70 students, 67 parents
Age 17-18	7,013 students	61 students, 65 parents
Age 20-22	7,635 students	50 students, 35 parents

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Key emerging messages

- Intersectional interplay of **identity, capital** and **education system/practices** (field) are key influences on young people's STEM trajectories

The extent to which a young person's identity aligns (or not) with a STEM discipline strongly shapes their STEM trajectory

Identity

Capital

Field

The 'right sort' of STEM capital supports STEM identity development and progression within a given field
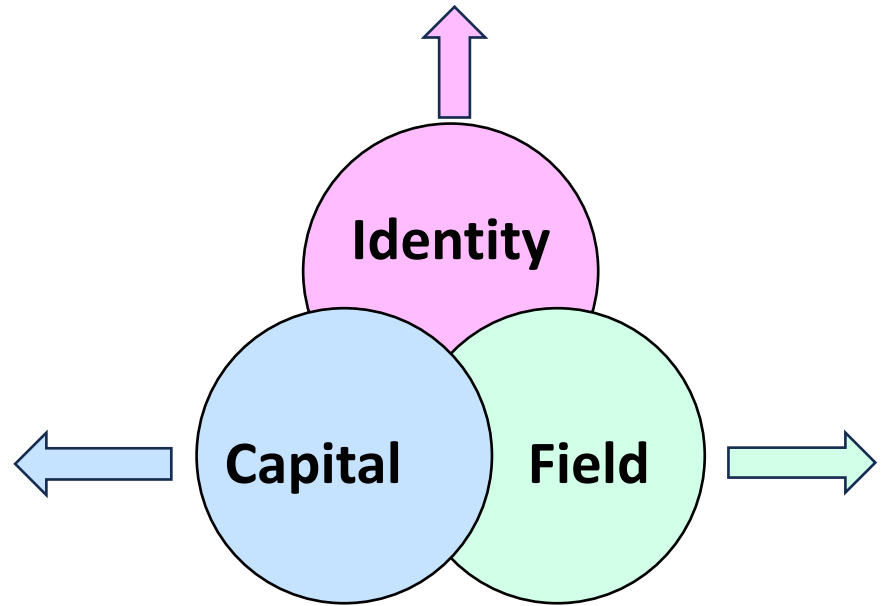
Practices in STEM education can hinder young people's identification with and progression in STEM

Science/ STEM Capital

- Developed in ASPIRES project and since extended
- Draws on Bourdieusian conceptualisation – science/STEM-related resources
- Produces a sense of whether science/ STEM is for 'people like me', or not and resources to support attainment and aspiration
- Students whose science capital is valued, supported and recognised are **significantly more likely to aspire to and participate in post-18 science/STEM and have a 'science identity'**
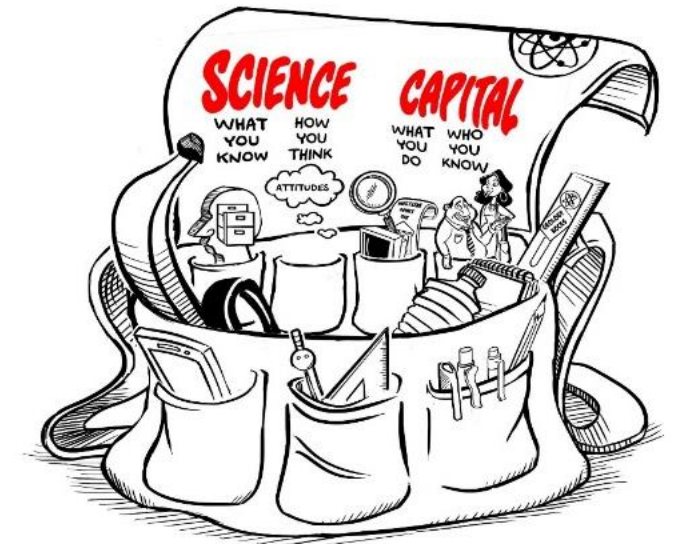
Science/ STEM identity

- Combines sense of self *and* recognition by others (Carlone & Johnson 2007)

- Identity and recognition mediates learning and interest

- Growing international focus on science identity – e.g. PISA 2025

- Gender, classed and racialized: teaching and learning practices and societal discourses socialize young people (esp. young women, Black and working-class students) into feeling that science/ STEM is not "for me", irrespective of attainment (e.g. Kate)

- Associations of science/STEM with 'being clever' – esp. in maths ('being the best')

Science /STEM as 'clever' and 'male'

- Over time, pervasive reinforcement of STEM as 'hard'/ difficult/ for the clever

- Popular notions of "cleverness" are highly gendered, classed and racialized (aligned with White, middle-class masculinity)

- Mediates interest and attitudes to STEM
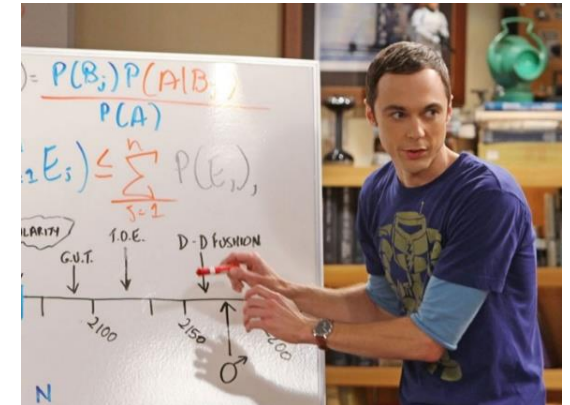
Exacerbation over time of associations of science with 'masculinity' and 'cleverness'

- E.g. Victor (white, middle-class boy, goes on to Astrophysics degree):

    Y6:   "You don't have to be clever to do science"

    Y8:   "I think you have to be a little clever … yeah, you probably have to be quite clever"

    Y9:   "People keen on Science … um they're sort of … they're not average people, they're more … they're more clever, they're cleverer than most people"

    Y11:   "Er, yeah, you need it, yes"

Field

- Schools/ teachers influence extent to which young people's science capital (identity, interests, experiences) are recognised, valued and realised, or not, in the classroom

- Even extensive home science capital can be mitigated and negated by school science – come to see science as 'not for me' (e.g. Vanessa).

- Everyday practices in ISL settings can also exclude or support young people's STEM identity and participation.

Field: Educational factors and practices

- Educational gatekeeping practices in England (including 'Triple Science') – strongly related to STEM A level and degree trajectories

- Patchy and patterns careers education and support

- Teachers, curriculum, school science:
  - Teachers reinforce STEM stereotypes around 'difficulty', 'boy brain', 'tomboyish'
  - Differential support: Boys and students with high cultural capital were the most likely to report receiving encouragement from teachers to continue with science. High STEM aspirations of Black students – but less support to realise
  - Over time, practices of cultivation and weeding out, young people are socialised into dominant ideas around science/ STEM – implications for future

Example longitudinal case studies

Davina

- White English/European upper middle-class young woman

- Consistent, long-term identification with science age 10-21

- Shifts in terms of disciplinary orientation over time (biology > physics > chemistry)

Sources: Archer et al., (2012), (2016), (2017), in preparation

Davina age 10-11

- Identifies self and by others as "intelligent" (e.g. "certainly she's intelligent … a very high achiever", father)

- High levels of family science capital

- Science-focused school

- 'Into' science and aspires to be a scientist

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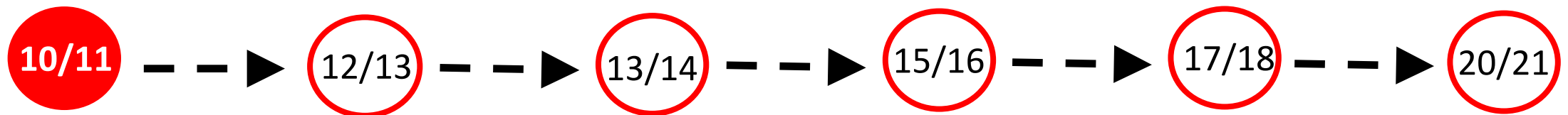
Davina age 12-14

- Aspiration: zoology or ecology

- "I would say there are like two types of people that are into science – either there are the really like geeky people...or there are **like people who are like me, who aren't like geeky but they have a knack for it** ... I play the guitar and do rowing and obviously the girly stuff that **other normal girls** do"

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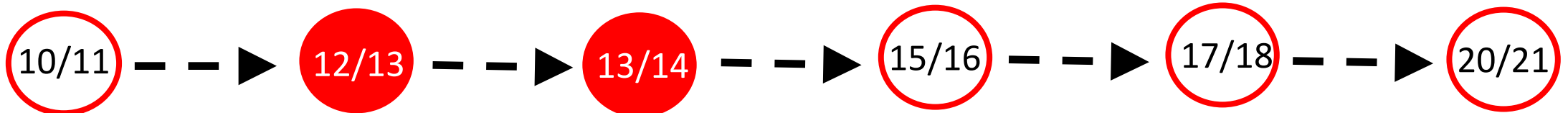
Davina age 15-16

- "I'm more a kind of physics-y person"

- "People who do, let's say Physics, and like … Maths [they] tend to be **extremely intelligent people**"

- "**I wouldn't say I'm a particularly feminine person** at all. I mean you know like I swear quite a lot (laughs) […] **I swear like a sailor** … I don't really dress particularly feminine… don't have a particularly feminine voice either"

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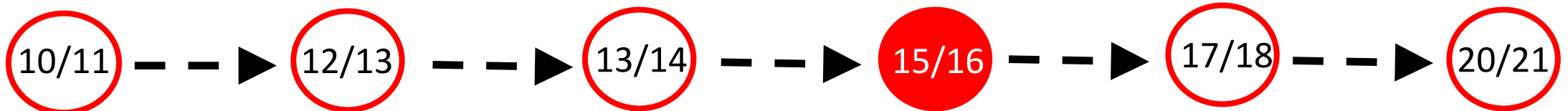
Davina age 17-18

- Aspires to chemistry degree, maybe PhD

- "I mean certainly if someone said 'do you think you're clever enough to do physics at university?' I would say definitely not, most definitely not … like **no way I could do physics at university**. … I mean I guess I'm probably smart enough to like get the A level but then I don't think that necessarily means that I'm actually like that good at physics"

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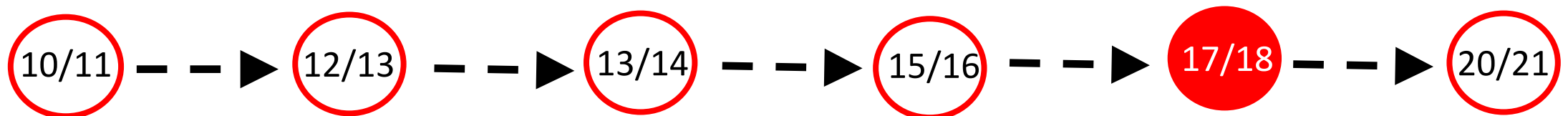
Davina age 20-21

- Studying for chemistry degree. Plans to go into different sector after graduation

- "**I'm *kind* of a chemist** […] there are definitely moments where I sort of think like 'oh my God, I'm so stupid' […] '**what kind of genius do you have to be to be doing this?**' […] I feel like everyone else is so much smarter than me, no one else is struggling […] but like I am and **I shouldn't be here**"

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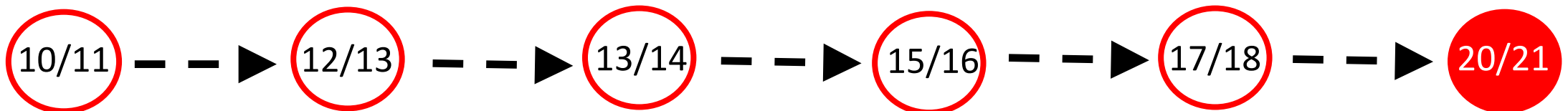
Summary points from Davina's case

- Interaction of identity, capital and field

- STEM practices play a part in cultivating and weeding out potential students, by gender, race and class

- Particularly notable in areas like physics

- Degree entry is not the 'end':

    - Under-represented students most at risk of non-completion.

    - 32.8% of female STEM students experienced sexism in last year – most acute in physics and engineering. Threatens ongoing participation.
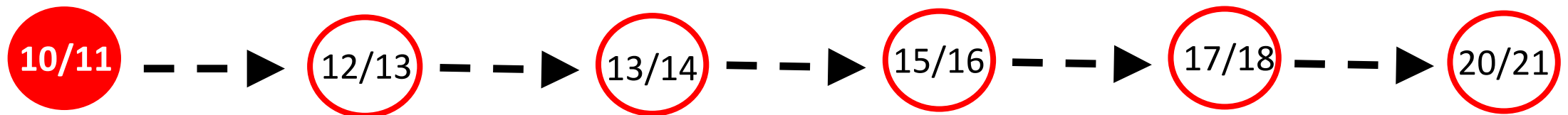
Laylany – an engineering trajectory

- White working-class young woman
- No history of HE in family
- Self-describes as 'not girly'
- Becomes mechanical engineer

Laylany age 10-11

- Mum encourages her tinkering & fixing at home and talks about science
- High science capital friend opens up more STEM enrichment
- Sees self/ recognised as good at maths and tecchie

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Laylany age 12-16

- Step-dad introduces to air cadets
- 'Not girly', plays rugby
- Enjoys air cadets – new engineering experiences
- Develops strong interest and identity in engineering
- Teacher channels her to double science
- Attains grades to access FE engineering course

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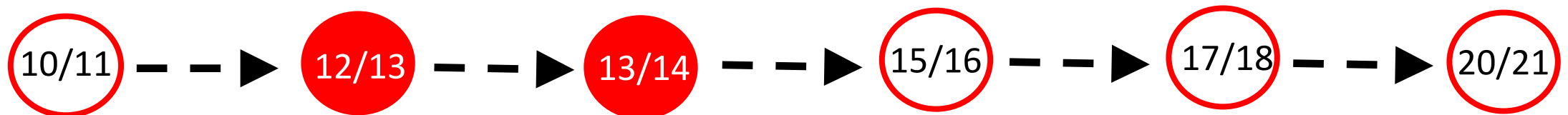
Laylany age 17-18

- Applies for aeronautical engineering diploma
- Aeronautical engineering course closes
- Cannot afford to travel to other course so takes local mechanical engineering diploma
- Sexism from male peers on FE course – but supported by tutor and talks from women engineers

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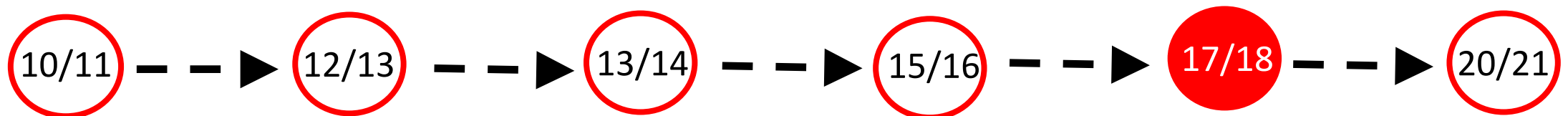
Laylany age 19-21

- Work experience at local engineering company
- Later applies for apprenticeship, given full time job
- Sexism from male peers at work but 'proves herself'
- Moved into quality control
- Enjoys work, plans to stay, aspires to be manager

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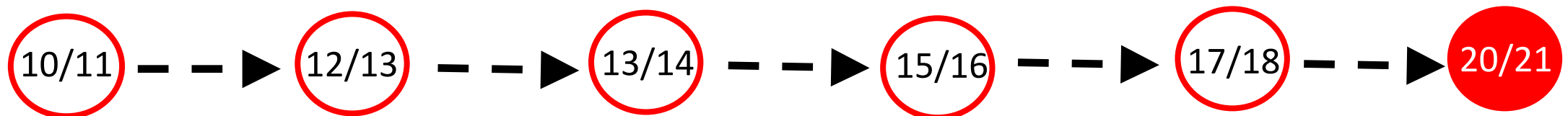
Laylany – summary points

- Importance of capital for generating and supporting identity and interest
- Field presents (ongoing) obstacles/risks – e.g. course closure, sexism from peers, that require capital, luck and identity work to navigate

Danielle
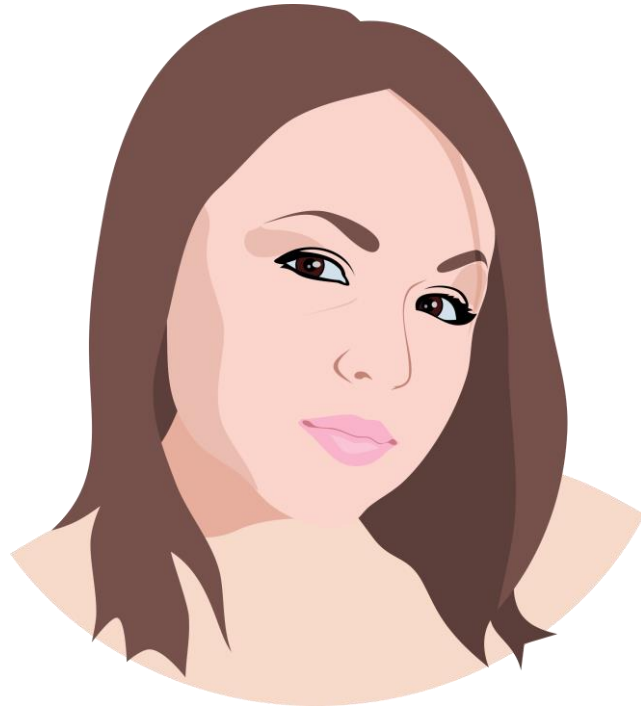
- White, working-class young woman
- Self-defines as "glamorous", "girly" girl
- No family history of HE, low science capital

Source: Archer et al. (2017)

Danielle age 10-11

- Strong interest in science, aspires to be a scientist
- Early informal science learning activities and experiences
- No family history of HE: "All of my family is not clever", "No one in my family has ever been to University"

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Danielle age 12-16

- Aspiration to be a scientist

- Raises attainment from "bottom" to "top sets"

- Takes non-elite science route ("Triple Science is too hard.. I wouldn't have done it, I'd have failed, so there was no point")

- Develops love of physics and wants to pursue at A level

- Disappointed by B grades at GCSE

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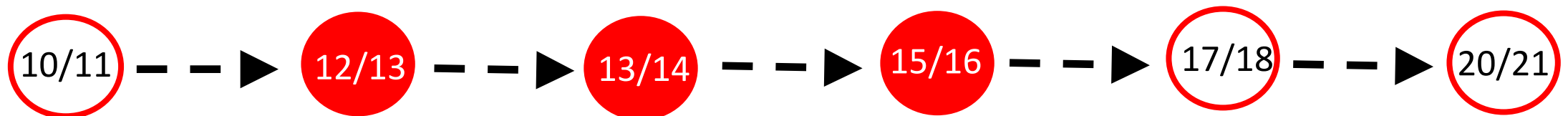
Danielle age 17-18

- Applies for physics A level but 'channeled' away by school

- Femininity-physics disconnect: ""I'm a bit of a party girl … I like make-up and hair … but then I do like the kind of school side. Like everyone thinks I'm really dumb, but I'm not. I seem quite dumb I suppose… because like I do all my make-up and hair and just seem a blonde bimbo"

- "My dad turned round to me the other night and went 'you ain't clever enough to go to college'. I went, 'yes I am, shut up'. Like he doesn't know I'm clever. He thinks what everyone else thinks, that I'm not clever because I look like this… But… I'll prove him wrong"

- "Well you look like you'd like to do Beauty, young lady" (careers fair)

- Sociology degree

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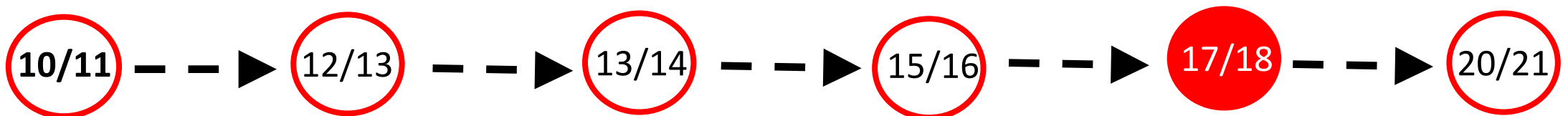
Danielle summary points
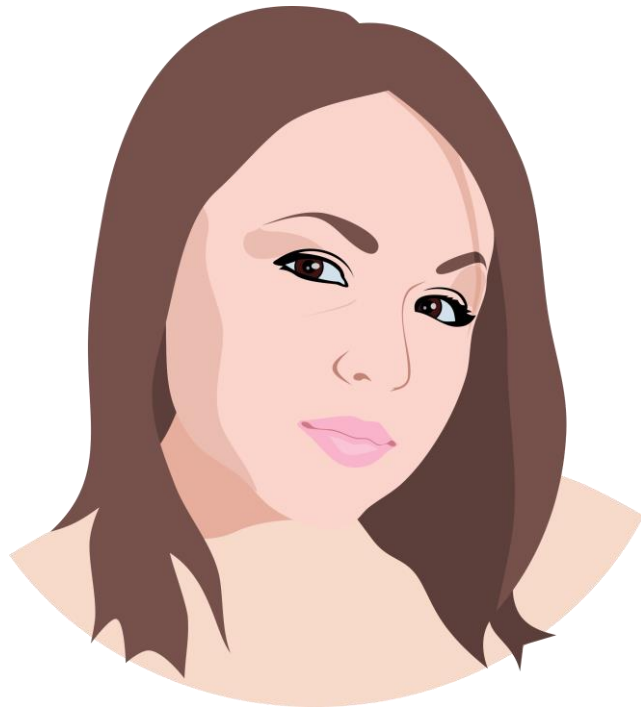
- 'Impossibility' of white working-class popular femininity and physics identity

- "The legitimate culture becomes experiences as an axiom, a *fait accompli*: Children all too soon stop asking 'Why?' Exclusion works most powerfully as self-exclusion" (Jenkins 2006 p107).

- Closing down of possibility of science by education system, national assessments and grade severity and lack of wider support
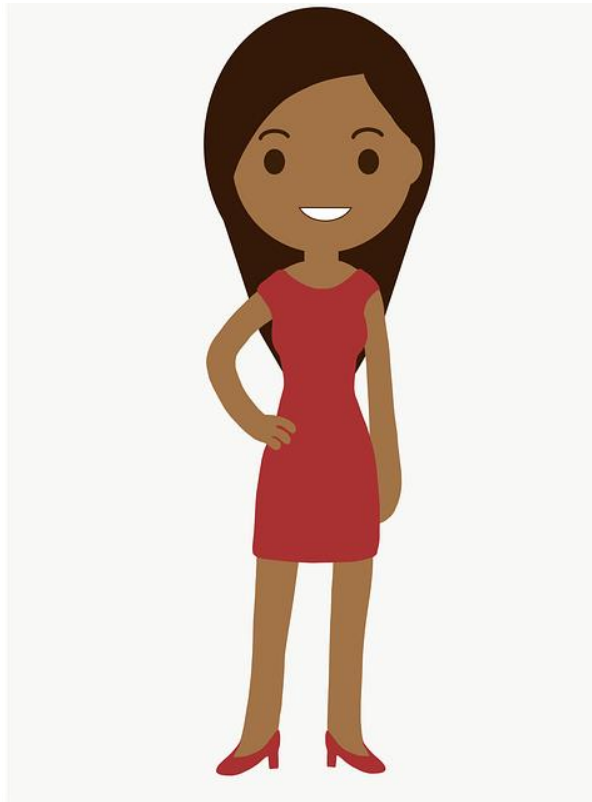
Vanessa

- Young, Black, working-class young woman

- African heritage

- Loves science, has lots of home support (especially dad, Robbie) but finds her "love for it wasn't enough"

Archer et al (2023) "My Love for It Just Wasn't Enough to Get Me Through": A Longitudinal Case Study of Factors Supporting and Denying Black British Working-Class Young Women's Science Identities and Trajectories | SpringerLink

Vanessa age 10-11

- Strong interest in science, aspires to be a scientist

- "My dad would like me to get a bit interested in science ... He buys quite a lot of science things for me".

- "I think that most people [in my class] don't like science because the noise we get when we hear we've got science is just so horrible …When they upset the teacher, I feel upset too … I don't like the way they treat our teachers"

- "Actually, some African people like science a bit more, because science in Africa seems to be what's getting more money"

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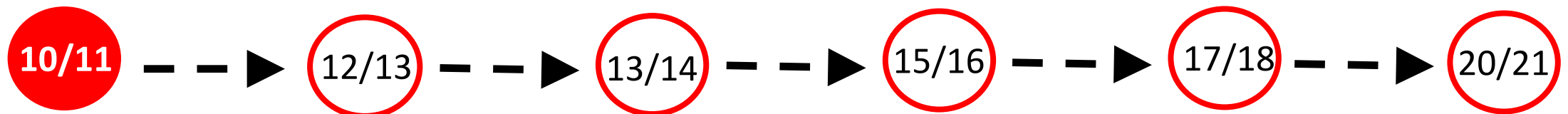
Vanessa age 12-16

- Still loves science, aspires to be forensic scientist
- "If you're really girly you just don't see yourself working in Mechanics, do you? And you don't see yourself doing Physics"

- "I'm not really the skirt and heels kind of person".

- "I've been watching a lot of CSI. That's probably my one big thing. Like I can't stop! CSI: Miami, that's just the only one I watch".

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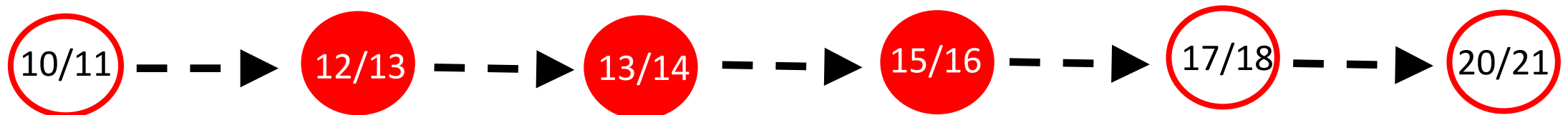
Vanessa age 17-18

- Gets all B grades. Starts A level biology but drops it

- "I've dropped science. It was harder than I thought. … I got Bs in everything really. I don't know, I just find it difficult. I like it, don't get me wrong, I loved it, but … like my love for it just wasn't enough to get me through. I wish my grades were a bit better and I found it easier … I just don't like how I'm feeling"

- "If we had the knowledge we have now, we probably would have taken the BTEC route, you know, through applied science or so. But I mean it was too late" (Robbie, dad).

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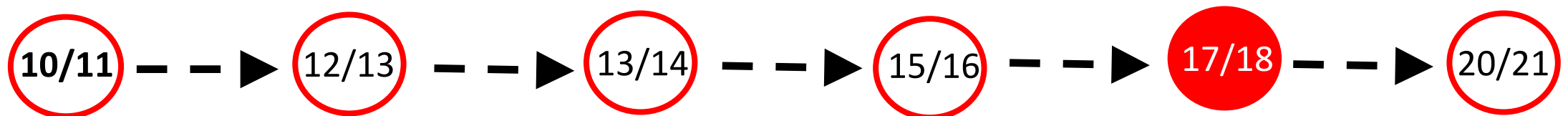
Vanessa summary points
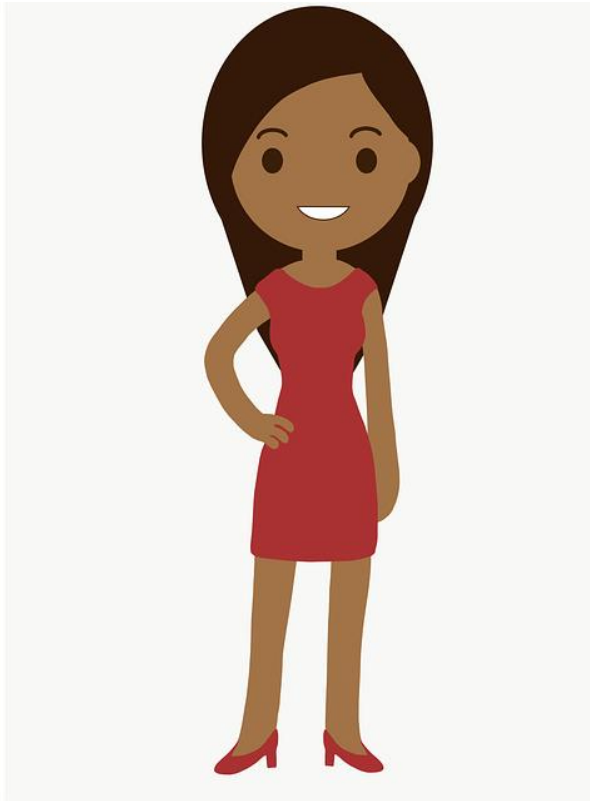
- Facilitating, valuable role played by Black cultural capital and habitus in supporting and encouraging science aspirations and trajectory – no lack of aspiration or family support

- Role of field in closing down Vanessa's STEM trajectory

- Intersectionality across race, class and gender

Summing up

- STEM trajectories are complex and challenging – interactions of identity/habitus, capital and field produce different (socially patterned) trajectories into/away from STEM
- Intersectional injustices provide constant pushing back against (under-represented) young people's science/ STEM interest and trajectories
- Not a 'lack' of interest, motivation, etc.

Suggestions for policy and practice

- Focus on changing practice – not young people
- Make STEM a vehicle, not a destination
- Move beyond silos and competition (improve the ecosystem)
- Our wider research shows that practitioners can make a big difference – especially where equity is embedded (not 'tick box') but often not given enough support/resource
- Intentionally foreground power and equity is key – not doing so is not neutral
- Value of critical professional reflection - working with discomfort – crucial for addressing privilege and power
- How to do this? Tools like the *Equity Compass* and *P/SCTA* can help

The Equity Compass and P/SCTA

- Support critical reflective practice among educators and practitioners
- Centrality of equity and social justice
- Based on premise that underpinning values and mind set will determine the equitable potential of your practice
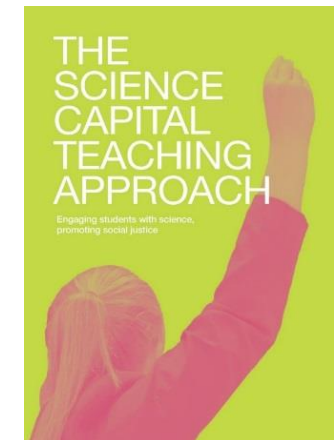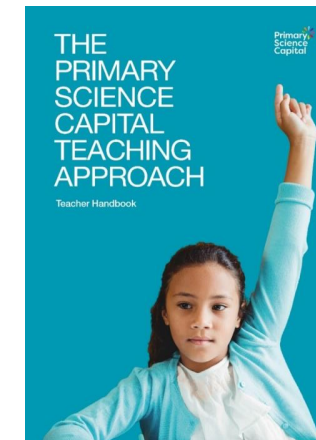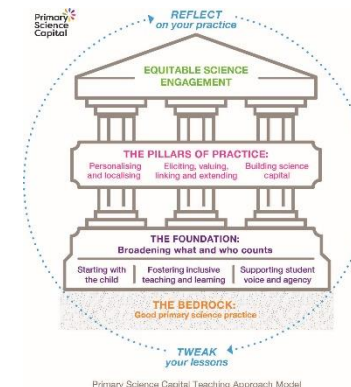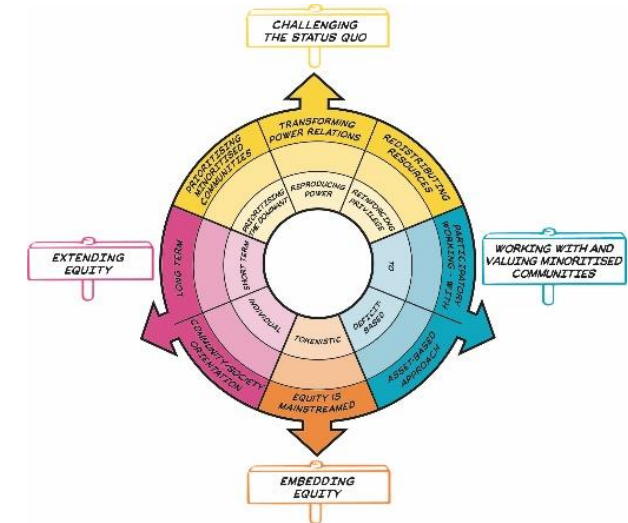
The Equity Compass – a tool for critical reflection

Equity Compass helps us to:

- Recognise and think about key dimensions of equity/social justice

- Use reflective questions to guide our thinking

- Consider how equitable practices are

- Map where we are – and map our progress (moving from inside outwards)
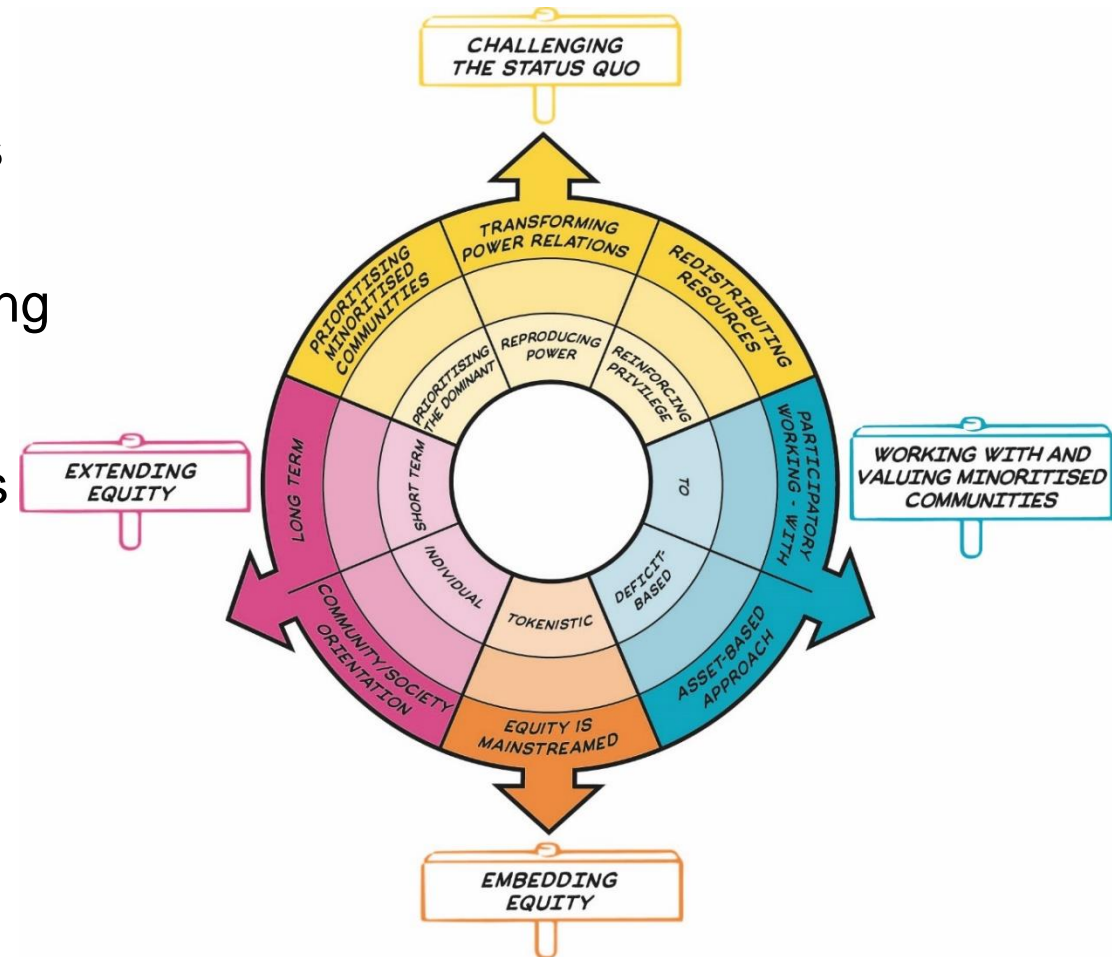
Testimonials from partners

"So it has really made me think … in a more structured way about things as well, rather than operating under this feels right or this feels wrong. I think that's a big shift. […] I think it's deepened my practice"

Now I can put names to what I'm doing. … I know what I'm talking about now. I'm more confident in it."

"It's completely changed the way we work."

Want to give it a try?

- **Read this**: summaries for [Teachers](), [School leaders](), [Funders]() and [STEM-Ambassadors]()
- **Watch this**: [2 minute animation]()
- **Do this**: [free, short online learning course]() for practitioners

Free, self-paced online course

(P)SCTA

- Originated in collaborative research and development work with secondary schools (over 4 years, 40+ teachers from schools in 4 cities)

- Evidence from 2 x year long trials showed significant increases in secondary students' science capital, attitudes to science and post-16 science aspirations

- Later updated and co-developed with primary teachers

- Focus on changing practice – not changing the young person (e.g. how engagement is organised, who has power, issues of representation, valuing what participants bring with them)
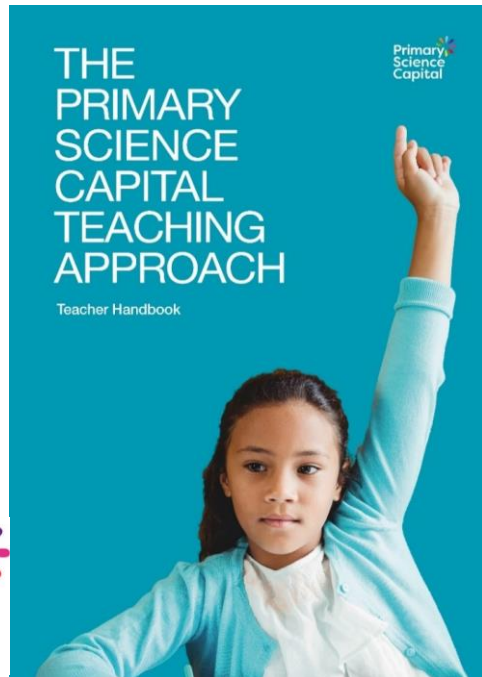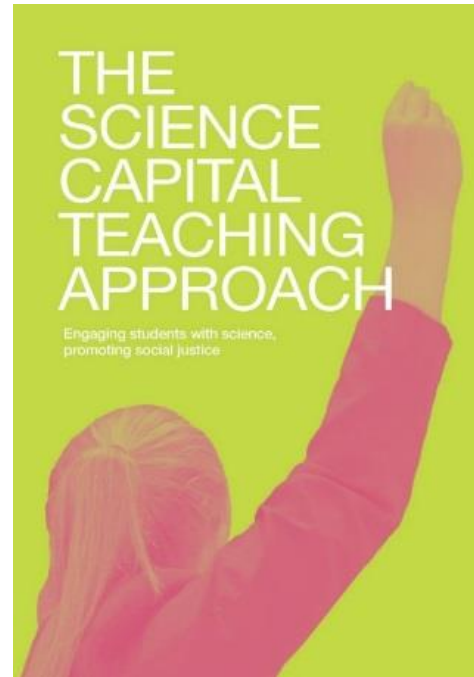
What difference has it made?
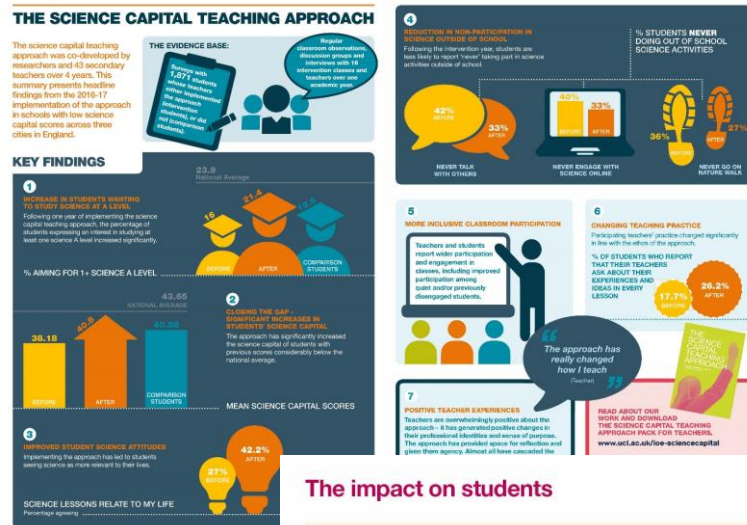
"I was surprised what a difference could be made by such a small thing. You could see the pleasure on their faces that everyone was interested in their knowledge and views" (Teacher)

SCTA Teacher Handbooks

Primary SCTA website
https://www.ucl.ac.uk/ioe/PrimarySciCap

SCTA Handbook and resources:
https://www.ucl.ac.uk/ioe/departments-and-centres/departments/education-practice-and-society/stem-participation-social-justice-research/science-capital-teaching-approach

Concluding thoughts

Some recent published analyses

- Reasons for not/choosing chemistry: Why advanced level chemistry students in England do/not pursue chemistry undergraduate degrees (wiley.com)

- Misfits or misrecognition? Exploring STEMM degree students' concerns about non-completion - Archer - 2023 - Science Education - Wiley Online Library

- Full article: Get lucky? Luck and educational mobility in working-class young people's lives from age 10–21 (tandfonline.com)

- "Make it more relevant and practical": Young People's Vision for School Science in England (ucl.ac.uk)

- "My Love for It Just Wasn't Enough to Get Me Through": A Longitudinal Case Study of Factors Supporting and Denying Black British Working-Class Young Women's Science Identities and Trajectories | SpringerLink
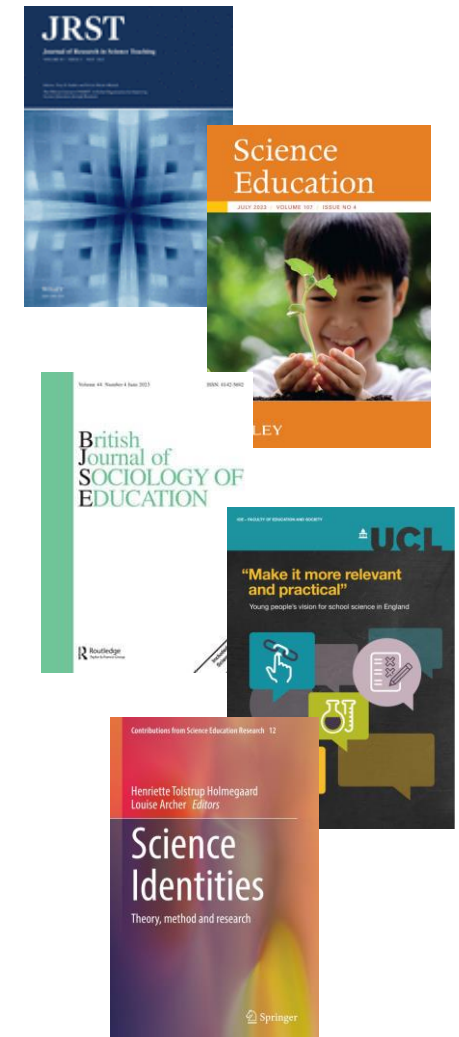
Some analyses in process:

Under review/ awaiting corrections:

- Students' experiences of sexism on (STEM and non-STEM) degrees
- The relationship of studying double vs. triple science on science/STEM A level and degree uptake
- Statistical modelling of the factors shaping STEM trajectories
- Young people's computer science trajectories
- Reasons for not/choosing mathematics degree
- Plus many more in development! (maths, engineering, careers education, family factors, etc.)

Contact our projects	Twitter	Website
ASPIRES	@ASPIRESscience	https://www.ucl.ac.uk/ioe/departments-and-centres/departments/education-practice-and-society/aspires-research
YESTEM	@yestem_UK	www.ucl.ac.uk/ioe-yestem
Making Spaces	@M4kingSpaces	m4kingspaces.org
Primary Science Capital	@PrimarySciCap	https://www.ucl.ac.uk/ioe/departments-and-centres/departments/education-practice-and-society/science-capital-research/primary-science-capital-project