

What shapes young people's STEM trajectories - and how can schools and HE better support these?

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Why focus on equity and inclusion in STEM?

- Extensive investments to widen (and increase) participation but science/**STEM remains dominated by privileged people** (e.g. White, male, middle-class, able-bodied, etc.) – especially in engineering, physics and computing
- Existing efforts are often **deficit**-based, trying to change young people
- But our research suggests that (i) lack of interest and motivation is not the main issue and (ii) schools and informal settings can play a role in excluding and dissuading students from science

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

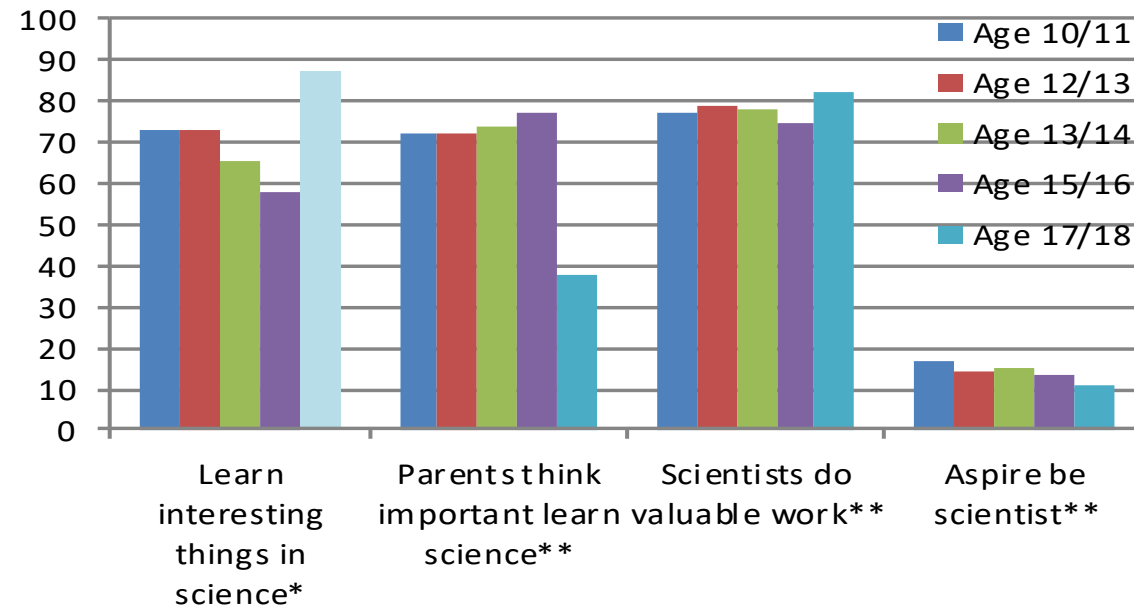


Design

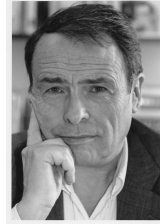
Age	Surveys (47,622 total)	Interviews (765 total)
Age 10-11	9,319 students (279 primary schools, England)	92 children, 84 parents
Age 12-13	5,634 students	85 students
Age 13-14	4,600 students	83 students, 73 parents
Age 15-16	13,421 students	70 students, 67 parents
Age 17-18	7,013 students	61 students,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

Liking science is not enough

Comparison of survey responses from Y6, Y8, Y9, Y11, Y13 students
(% strongly/ agreeing)



Conceptual framework



Interactions of *habitus*, *capital* and *field* produce patterns in science engagement and participation:

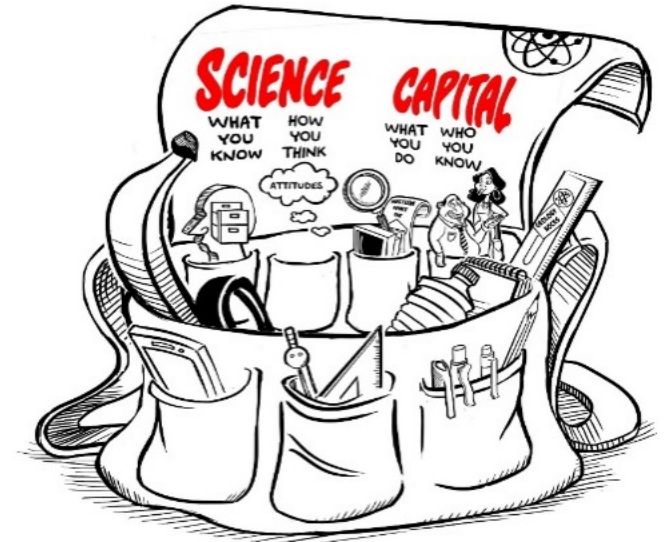
- **Habitus** - socialised, embodied dispositions shape whether science is 'for me', or not, formed through classed, gendered, racialized experiences: Gives a 'feel for the game'
- **Capital** – cultural, social economic and symbolic resources possessed and accrued, shaped by social axes: the 'hand' you can play in the game
- **Field** – 'space of positions and position-taking': the 'rules' of the game

Extent of 'fit' between habitus, capital and field shapes whether students experience science/ STEM as a 'fish in water', (Science families – where science is 'for me'), or not and produces differential trajectories



Science/ STEM Capital

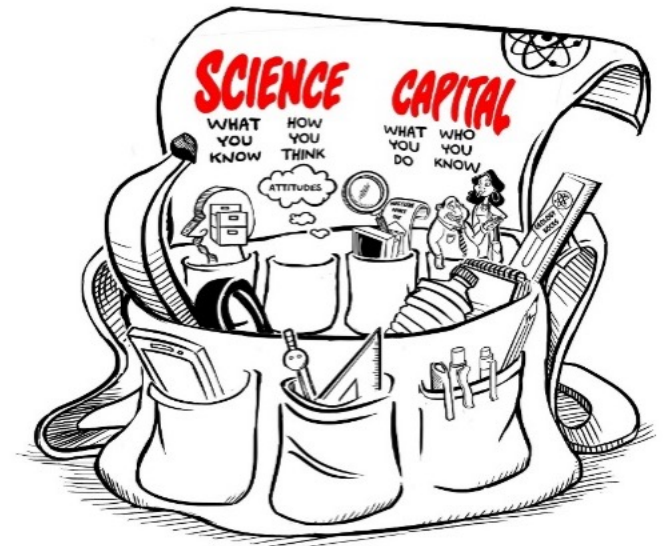
- Developed in ASPIRES project and since extended
- ‘Science capital’ is a ‘conceptual holdall’, combining socialised dispositions and science-related cultural and social capital
- Students whose science capital is valued, supported and recognised are **significantly more likely to aspire to and participate in post-18 science/STEM and have a ‘science identity’**





Main areas of Science Capital

1. 'Science literacy ("what you know")
2. Science-related attitudes and values ("how you think")
3. Out of school science behaviours ("What you do")
4. Science at home ("who you know")





How does Science Capital relate to STEM?

- Students with 'high' levels of science capital are statistically more likely to aspire and progress into post-16 STEM
- Statistical modelling shows science capital relates to attitudes to STEM and STEM A level and degree participation
- Science capital is most strongly related to participation in physics (7.8x more likely) and engineering (3.2x more likely) but also relates to maths and computing attitudes and participation

Science capital and families

Produces sense of whether science is for ‘people like me’, or not:

“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).

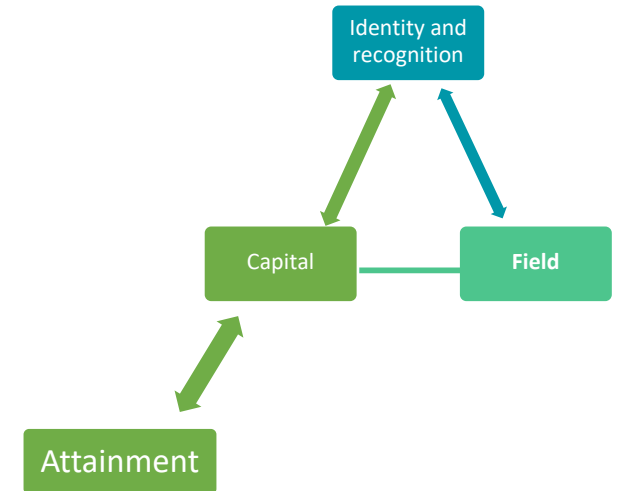
“Science is just where it’s at in my family” (Davina, student)

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

“They never talk about science” (Jack, student)

Capital also helps produce attainment

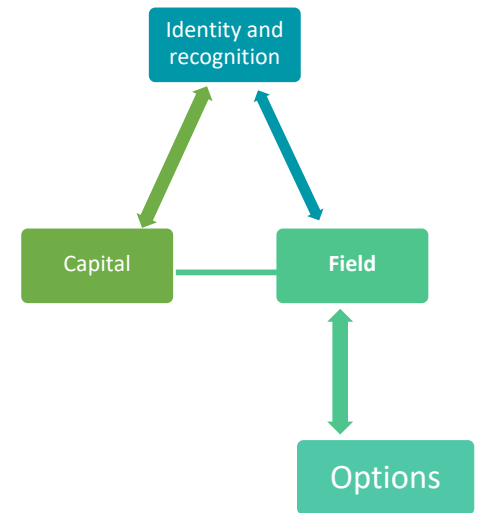
- E.g. families provide children with science-related kits, experiences, books etc.
- Support attainment through extra help, tutoring
- Accessing 'good' schools, arguing for access to top sets, etc.





Field

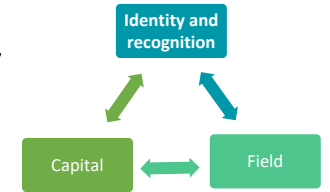
- Schools, teachers make a big difference to the extent that young people's science capital (identity, interests, experiences) are recognised, valued and realised, or not, in the classroom
- Evidence: even extensive home science capital can be mitigated and negated by school science – come to see science as 'not for me'.
- Everyday practices in ISL settings can also exclude or support young people's STEM identity and participation.
- Shapes availability of options



Field: Educational factors and practices

- Educational gatekeeping practices in England (including 'Triple Science')
- Patchy and patterns careers education and support
- Teachers, curriculum, school science:
 - Young people learn that science – especially physics - is only for the select (male, 'brainy') few
 - 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, through practices of cultivation and weeding out, young people are socialised into dominant ideas around science/ STEM – likely that future professionals will reproduce dominant patterns – especially in physics

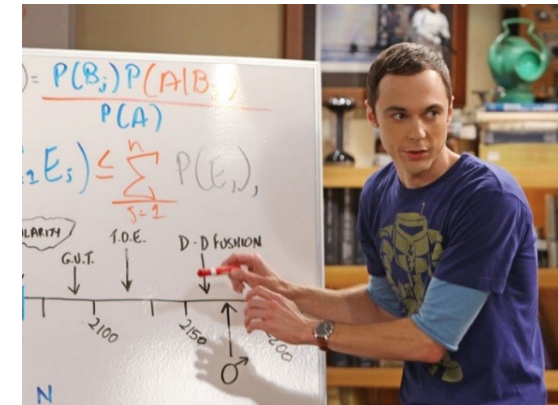
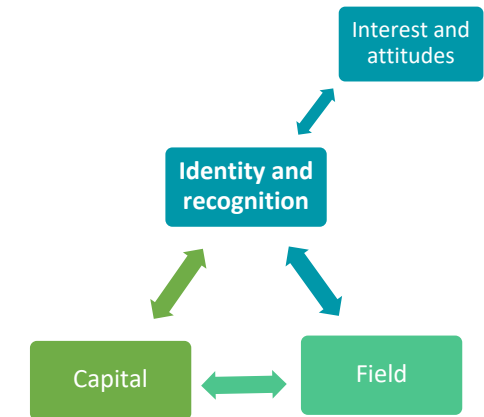
Science/ STEM identity



- 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 wider popular discourses socialize young people (esp. young women, Black and working-class students) into feeling that science/STEM (esp. physics, engineering and computing) 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):

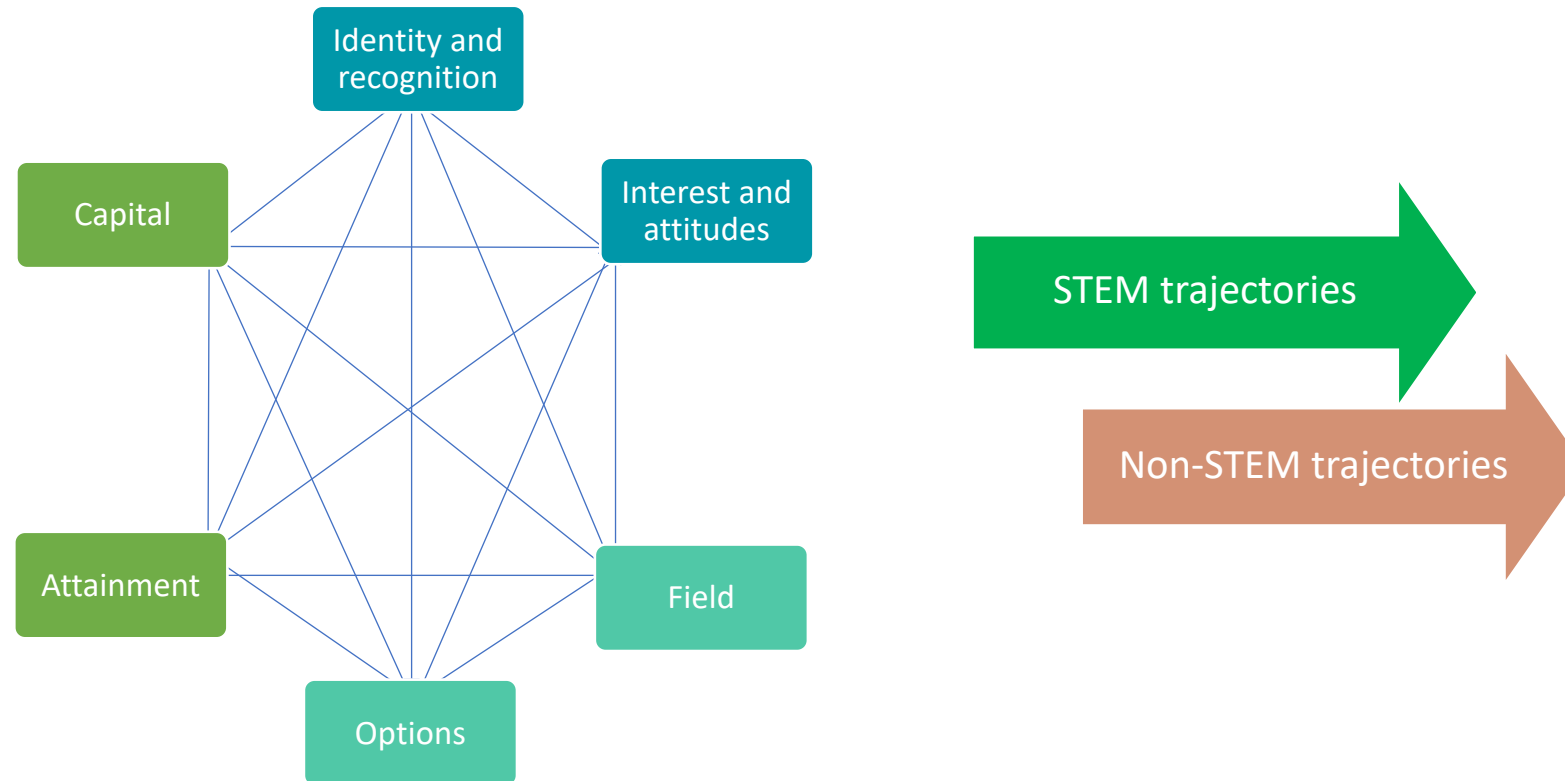
Y6: “You don’t have to be clever to do science”

Y8: “I think you have to be a little clever ... yeah, you probably have to be quite clever”

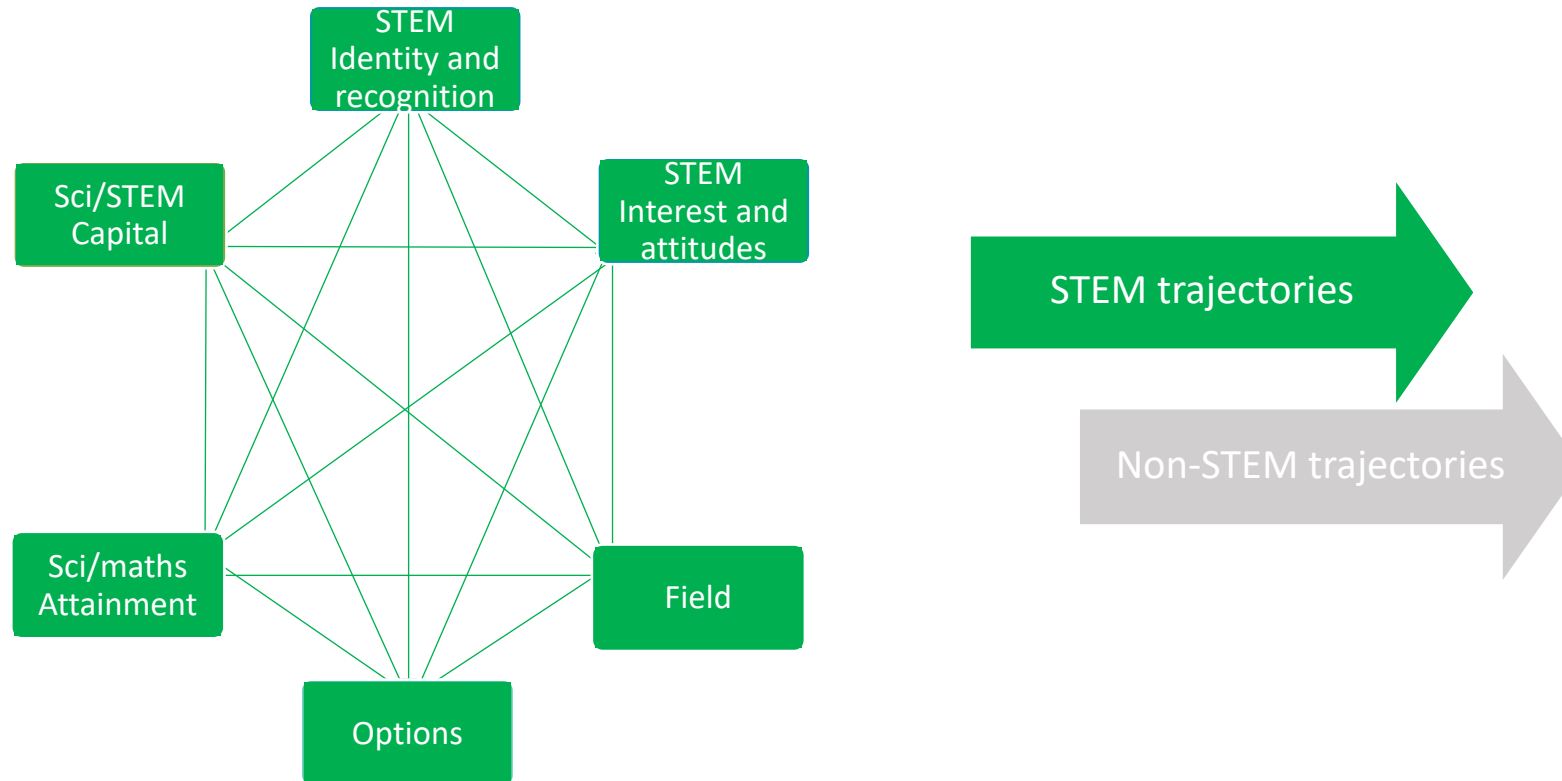
Y9: “People keen on Science ... um they’re sort of ... they’re not average people, they’re more ... they’re more clever, they’re cleverer than most people”

Y11: “Er, yeah, you need it, yes”

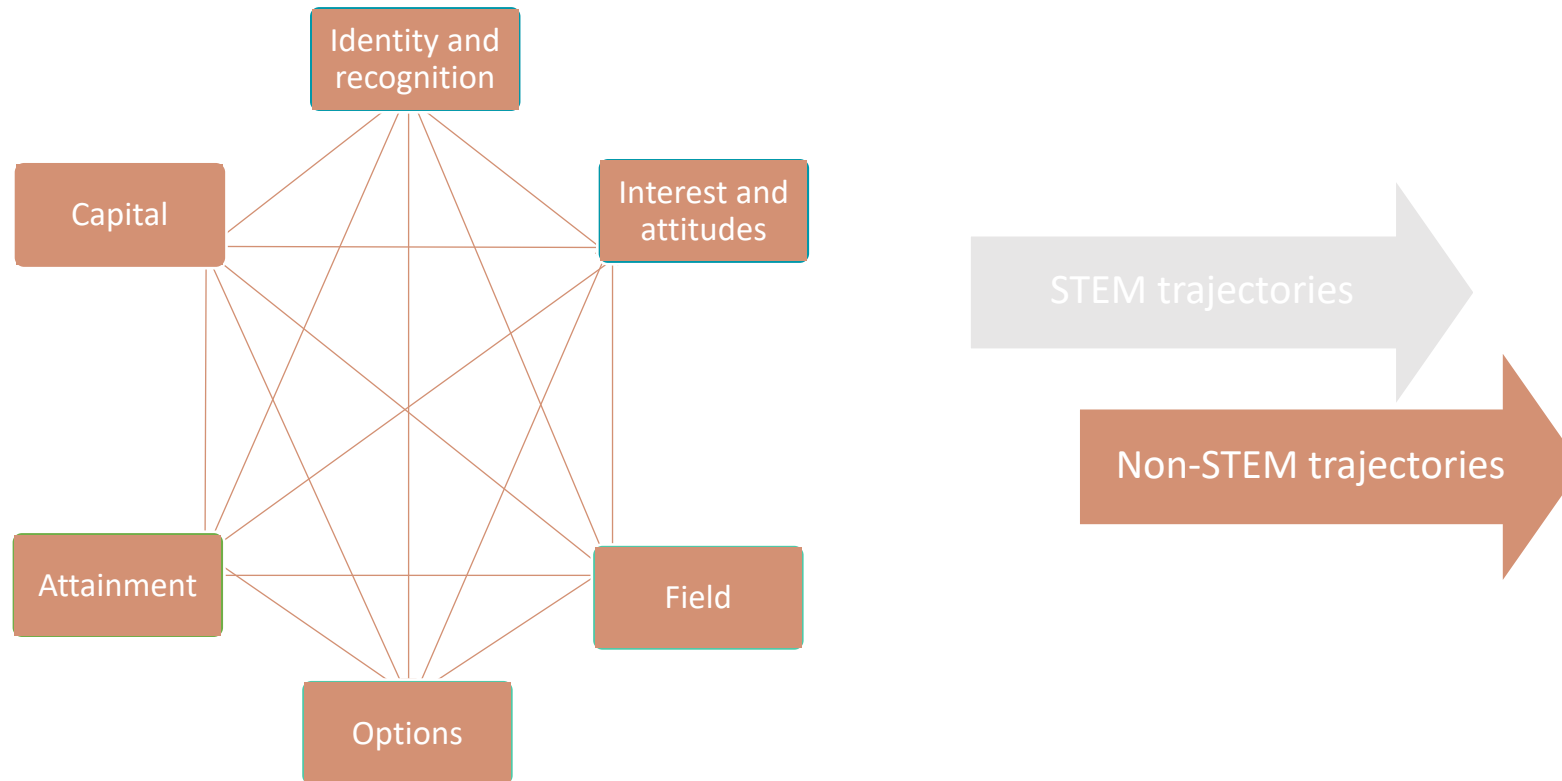
Relational interplays of factors produce trajectories



STEM alignment and support facilitates STEM trajectories



Mis- or other-alignment facilitates non-STEM trajectories





UCL



Example longitudinal case studies

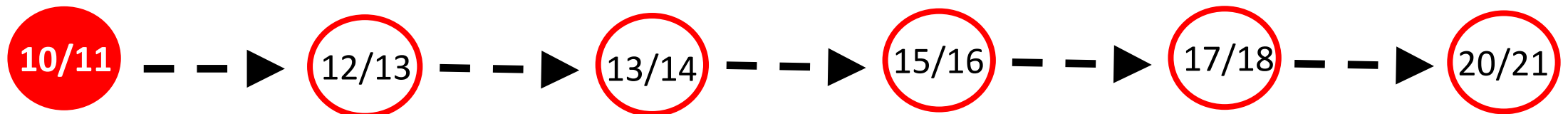
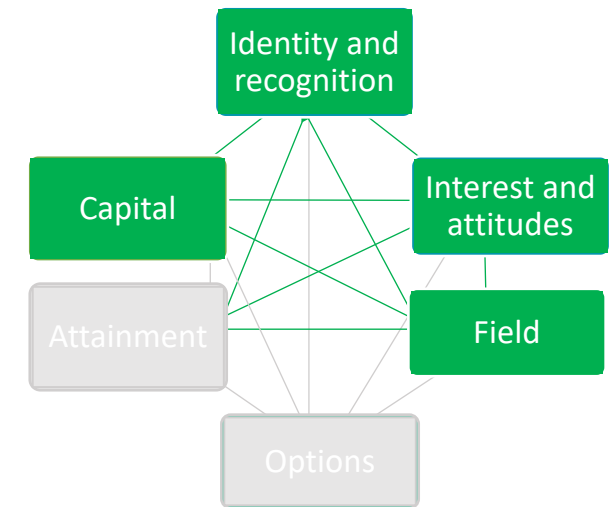
Davina



- 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)

Davina age 10-11

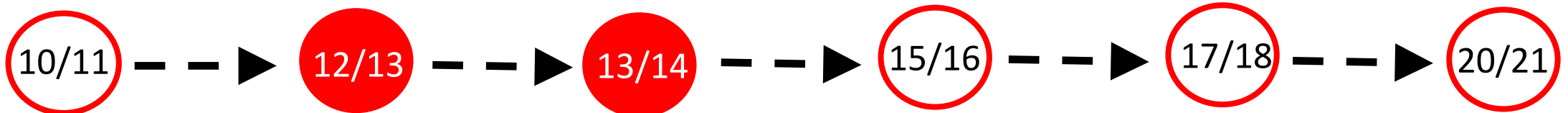
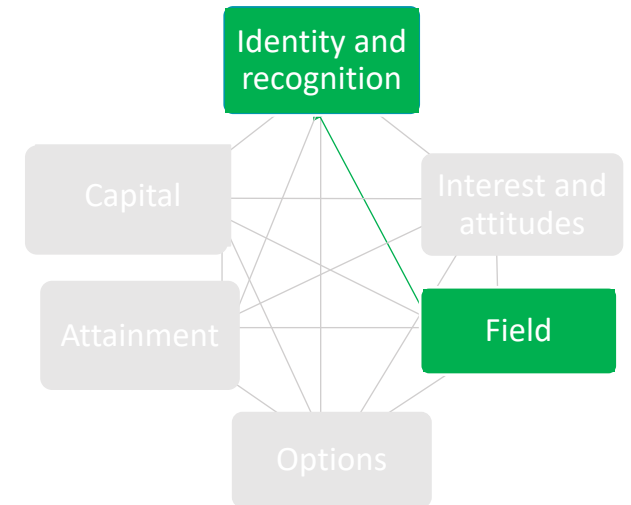
- Identifies self and by others as “intelligent” (e.g. “certainly she’s intelligent ... a very high achiever”, father)
- High levels of family science capital
- Science-focused school
- ‘Into’ science and aspires to be a scientist



Davina age 12-14



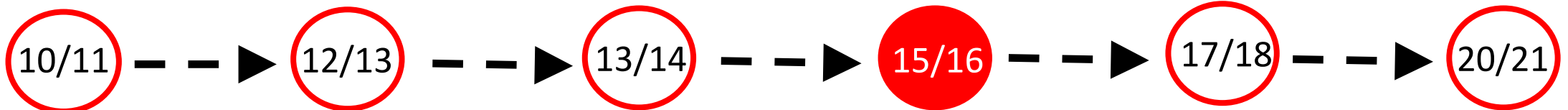
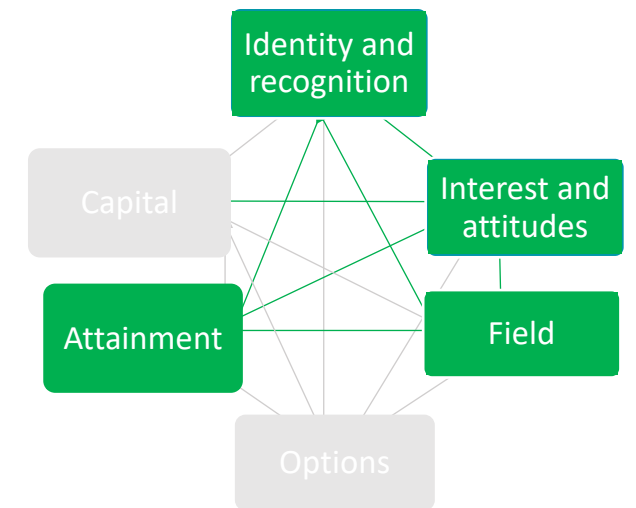
- Aspiration: zoology or ecology
- “I would say there are like two types of people that are into science – either there are the really like geeky people...or there are **like people who are like me, who aren't like geeky but they have a knack for it ...** I play the guitar and do rowing and obviously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



Davina age 15-16



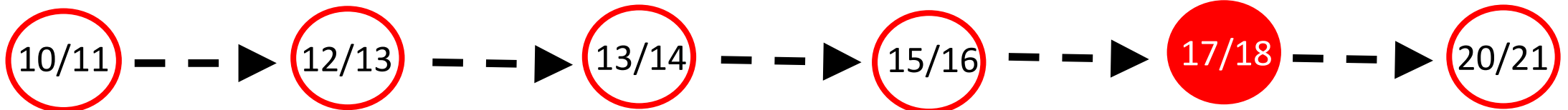
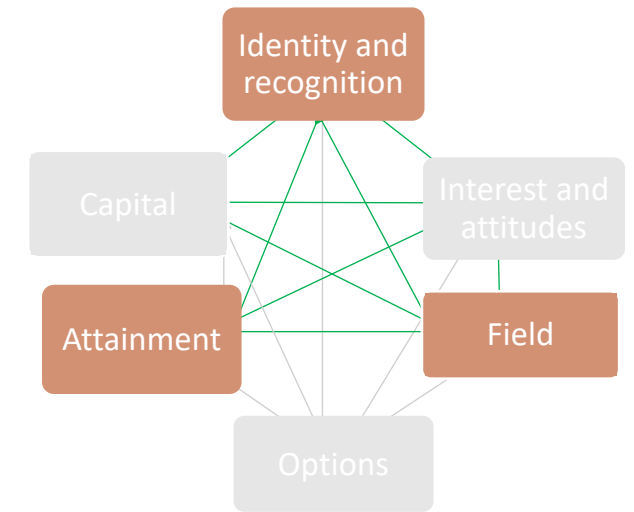
- “I’m more a kind of physics-y person”
- “People who do, let’s say Physics, and like ... Maths [they] tend to be **extremely intelligent people**”
- “**I wouldn’t say I’m a particularly feminine person** at all. I mean you know like I swear quite a lot (laughs) [...] **I swear like a sailor** ... I don’t really dress particularly feminine... don’t have a particularly feminine voice either”



Davina age 17-18



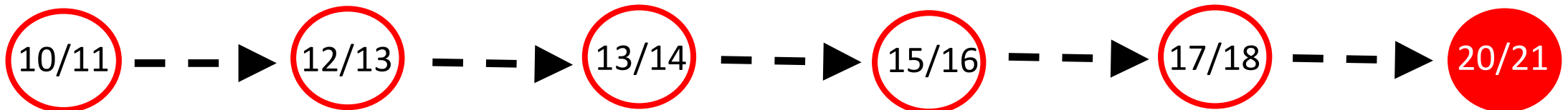
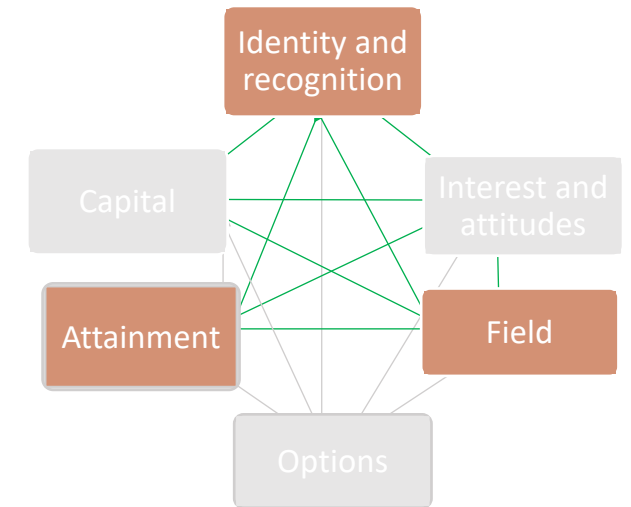
- Aspires to chemistry degree, maybe PhD
- “I mean certainly if someone said ‘do you think you’re clever enough to do physics at university?’ I would say definitely not, most definitely not ... like **no way I could do physics at university**. ... I mean I guess I’m probably smart enough to like get the A level but then I don’t think that necessarily means that I’m actually like that good at physics”



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**”

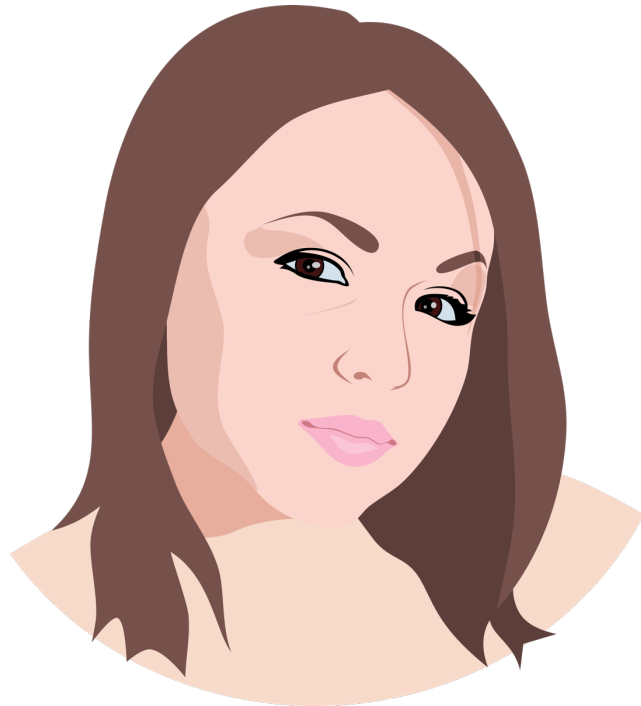


Summary points from Davina's case



- Identity work and STEM trajectories are **always in process**, shaped by **interactions** of factors
- STEM plays a part in cultivating and weeding out potential students, by gender, race and class
- Issues relating to gender and physics were common across the wider data
- Degree entry is not the 'end' – e.g. 32.8% of female (cf. 5.2% male) STEM students experienced sexism in last year – most acute in physics and engineering. Threatens ongoing participation.

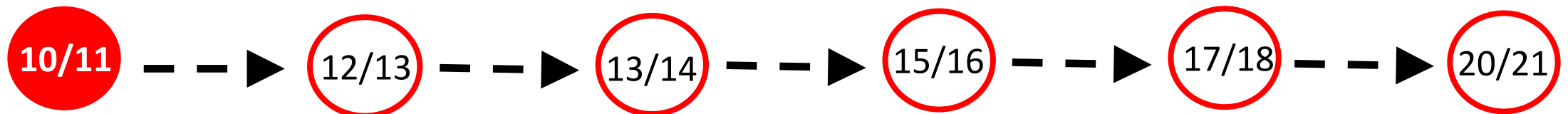
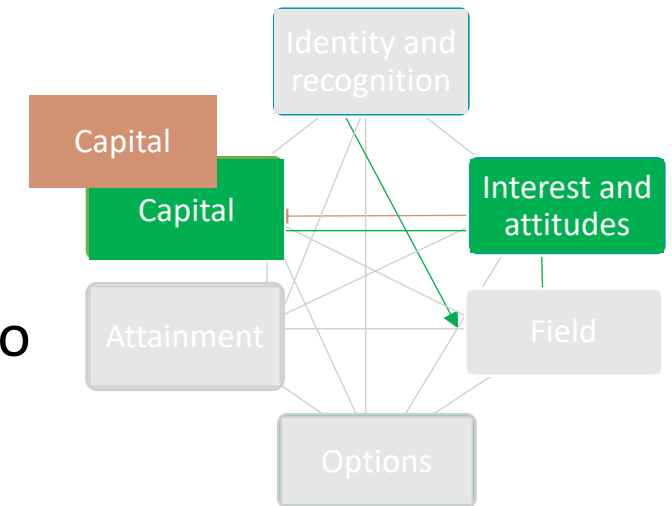
Danielle



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

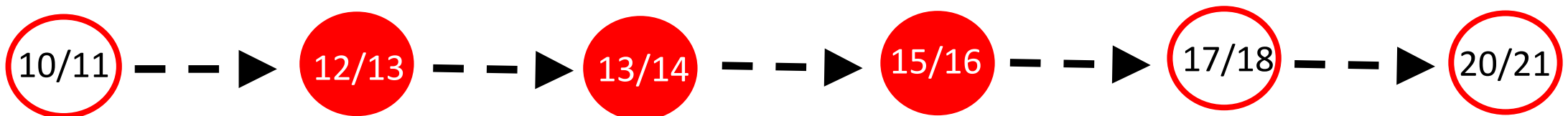
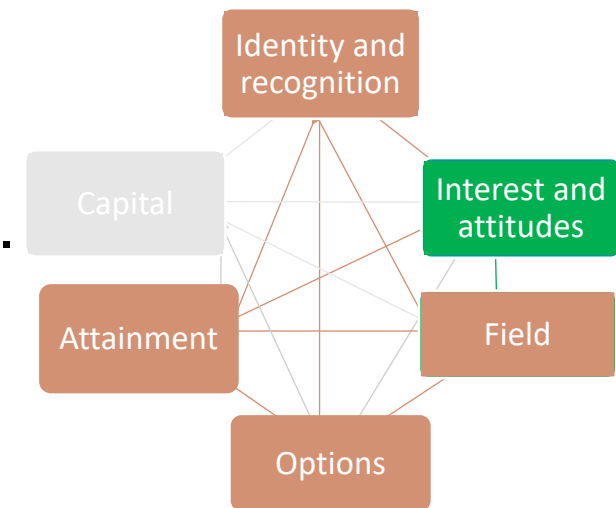
Danielle age 10-11

- 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”



Danielle age 12-16

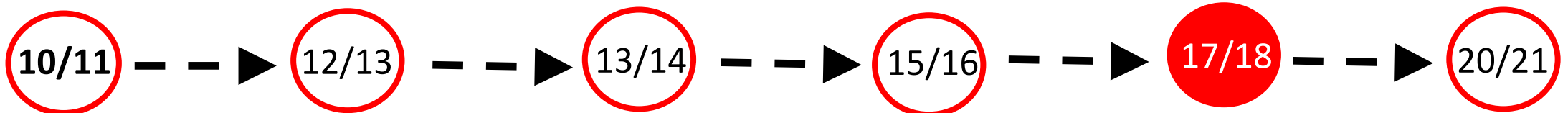
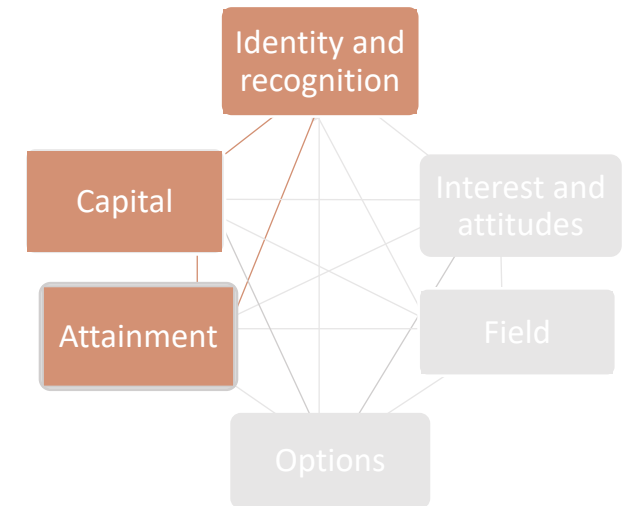
- Aspiration to be a scientist
- Raises attainment from “bottom” to “top sets”
- Takes non-elite science route (“Triple Science is too hard.. I wouldn't have done it, I'd have failed, so there was no point”)
- Develops love of physics and wants to pursue at A level
- Disappointed by B grades at GCSE



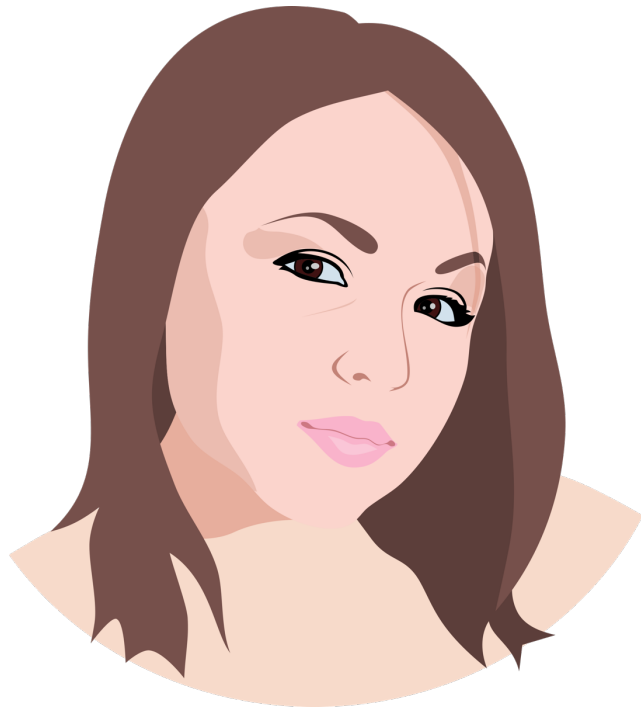


Danielle age 17-18

- 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



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

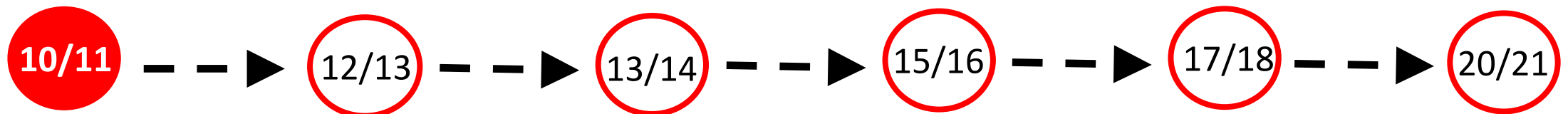
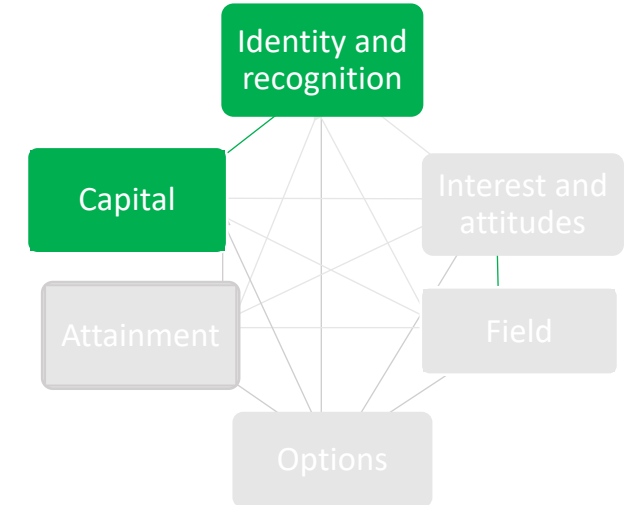
Laylany – an engineering trajectory



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

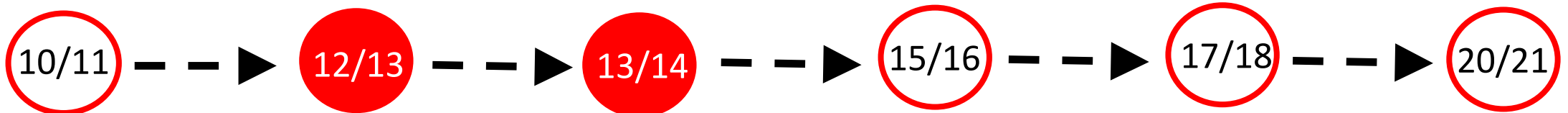
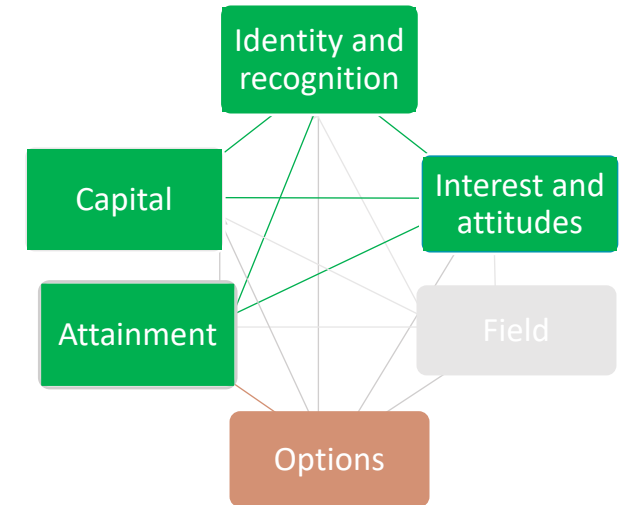
Laylany age 10-11

- 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



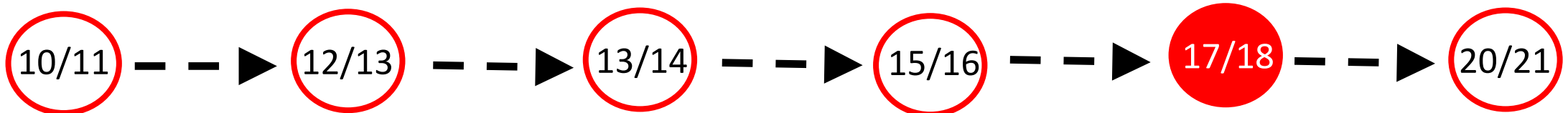
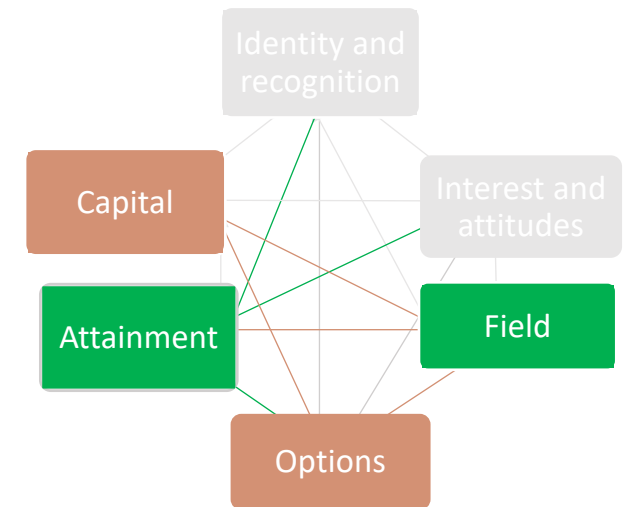
Laylany age 12-16

- 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



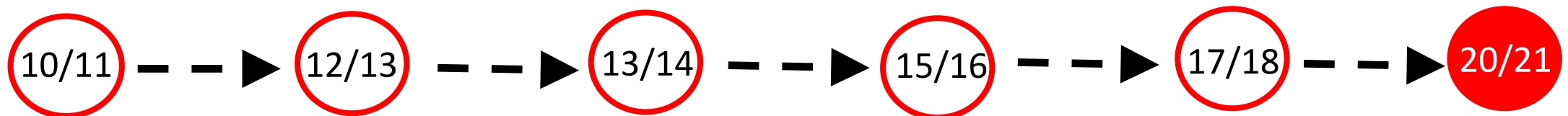
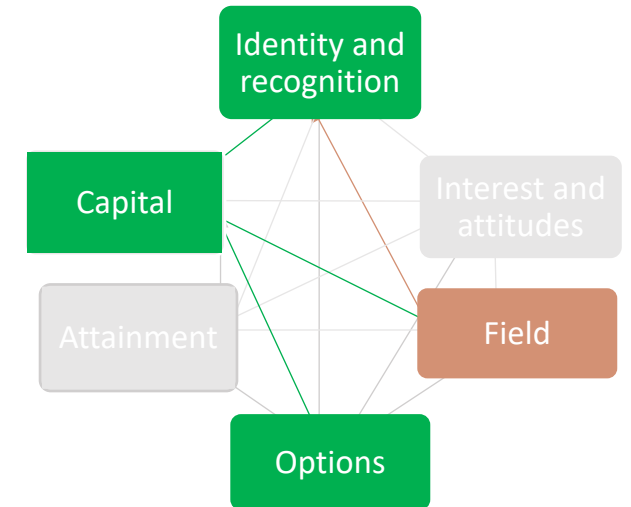
Laylany age 17-18

- 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



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



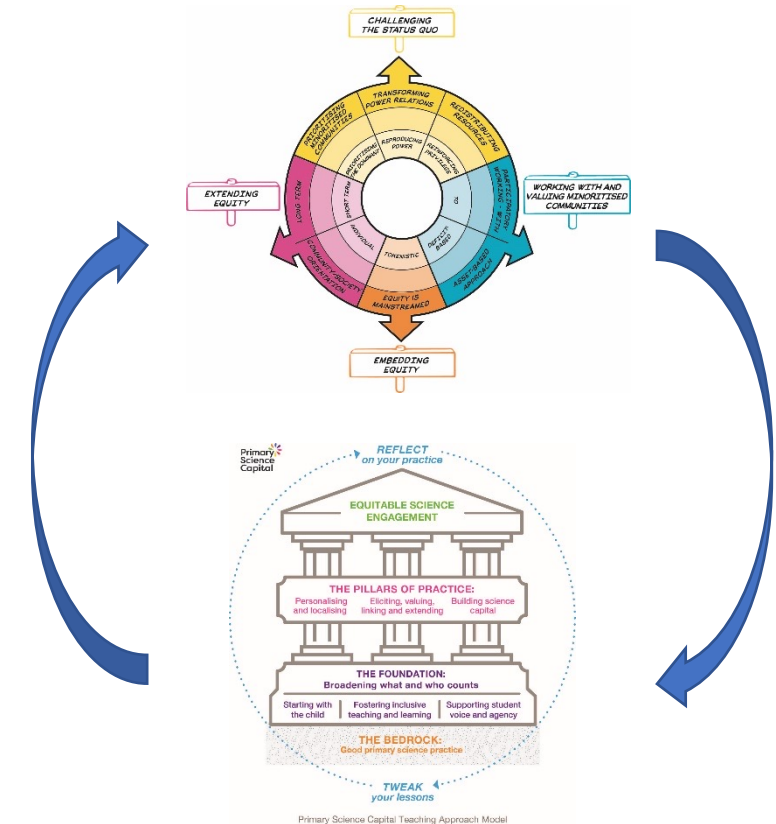
Laylany – summary points



- 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

What can we do to support STEM trajectories?

- Its not (just) what you do - but the way that you do it!
- Value of making central equity and social justice
- Underpinning values and mind set will determine the equitable potential of your practice
- Two elements: the **Equity Compass** and the Science Capital Teaching Approach





The Equity Compass

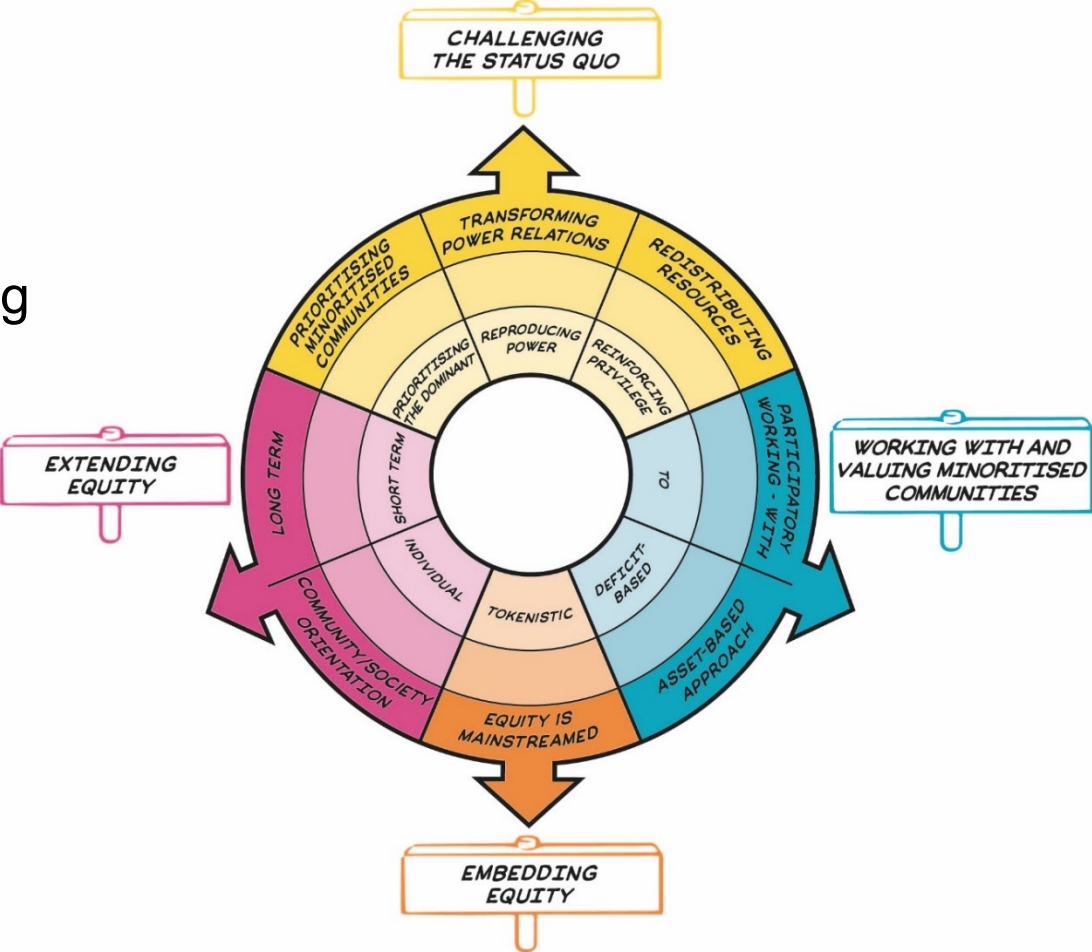
- Youth Equity + STEM project (2017-2022), 5-year UK-US research-practice partnership
- Collaboration with informal STEM learning organisations (science centres, zoo, STEM clubs, digital arts centre)
- Partnership: researchers, practitioners and young people aged 11-14



The Equity Compass – a tool for critical reflection

Equity Compass helps us to:

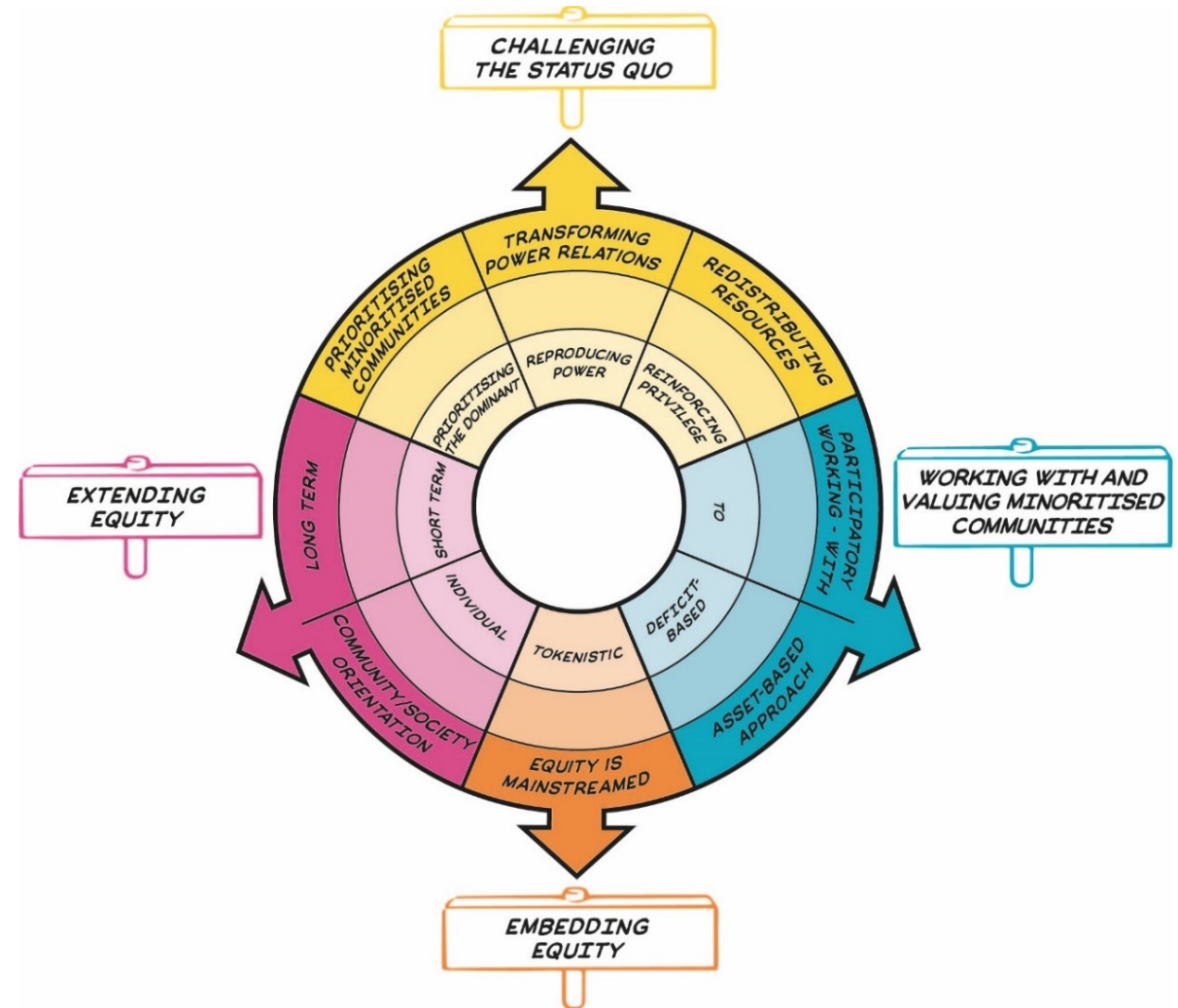
- Recognise and think about key dimensions of equity/social justice
- Use reflective questions to guide our thinking
- Consider how equitable practices are
- Map where we are – and map our progress (moving from inside outwards)





Key messages

- Change mind set and practice, not young people
- Make STEM a vehicle for equity, not a destination
- Small changes can make a difference – big changes can transform






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.”





I think our main thing would be **stopping and reflecting** on what we're actually doing.



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



What is the Issue?

- Inequity is an ongoing and important issue for schools. Research shows the impact of injustices on students' experiences, attainment, progression and well-being.
- Injustices are also an issue for school staff. It is a predominantly White profession, even in our diverse communities. Black and Minority Ethnic (BAME) teachers are under-represented in school leadership positions¹ and under-representation of BAME school governors².
- School governing bodies and school leaders ensuring clarity of vision, ethos and strategy need to be inclusive of and responsive to the needs of all. At present, school leaders and governance tools and training to address the complexity of this need are limited.

¹ Tereshchenko, A., Mills, M., & Bradbury, A. (2020). Making BAME teachers in England. UCL Institute of Education.
² Hollock, N. (2019). School Governors and Racial Equality in Schools. UCL Institute of Education.
 Kettlewell, K., Lucas, M., McCrone, T., Luff, J., & Sims, D. (2019). Investigative Report: October 2019. National Foundation for Educational Research.

Whereas **equality** means treating everyone the same and providing everyone the same opportunities, an **equity** approach advocates for differential treatment of people according to need, while also recognising and valuing differences between people. A **social justice** approach seeks to change the structures and practices that create and maintain inequalities.

What is the Issue?

- Science, technology, engineering and mathematics (STEM) participation remains dominated by privileged people (e.g., White, male, middle-class, able-bodied) and diversifying the sector remains a key challenge for policy and practice.
- Public engagement and outreach activities have considerable potential to engage diverse communities.
- It is important to focus on changing practices, rather than changing the young people. Currently, many initiatives take a deficit approach that considers young people as "lacking" the right interests, motivation or awareness, and seeks to change them – rather than considering what makes engagement difficult for them. Focusing on changing practices can lead to a more sustainable change.
- Practice within this sector is often based on a "common sense", which in some cases inadvertently reinforces inequalities. The sector would benefit from research-informed practice and improved capacity to understand and engage with the complexity of issues pertaining to equity and social justice.

Whereas **equality** means treating everyone the same and providing everyone the same opportunities, an **equity** approach advocates for differential treatment of people according to need, while also recognising and valuing differences between people. A **social justice** approach seeks to change the structures and practices that create and maintain inequalities.



Free, self-paced online course

Online Courses / Teaching



NEW

Equity in Informal STEM Learning: Using the Equity Compass

★★★★★ 5.0 (7 reviews)

Discover a new framework to help you support all learners and promote equity in informal STEM learning.

Go to course

837 enrolled on this course








<https://www.futurelearn.com/courses/equity-informal-stem-learning-using-the-equity-compass>

Concluding thoughts

- Inequalities are **complex** and challenging – produced through interactions of habitus, capital and field, that produce patterns in interests, attitudes, attainment, options and choices – resulting in differential trajectories into/away from STEM
- Educators are often not given enough support and resource to engage effectively
- Practitioners can make a big difference – especially where equity is embedded (not 'tick box')
- Value of critical professional reflection intentionally foregrounding equity
- Not what you do but **HOW and WHY that you do it** – values and mind set are key
- Equity Compass & SCTA can help support this across multiple levels
- But will mean working with discomfort – key to addressing privilege and power

Concluding thoughts



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