Engaging young people with STEM: A science capital approach

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Primary Science Capital

YOUTH EQUITY + STEM

ASPIRES 2
science and career aspirations: age 10-19

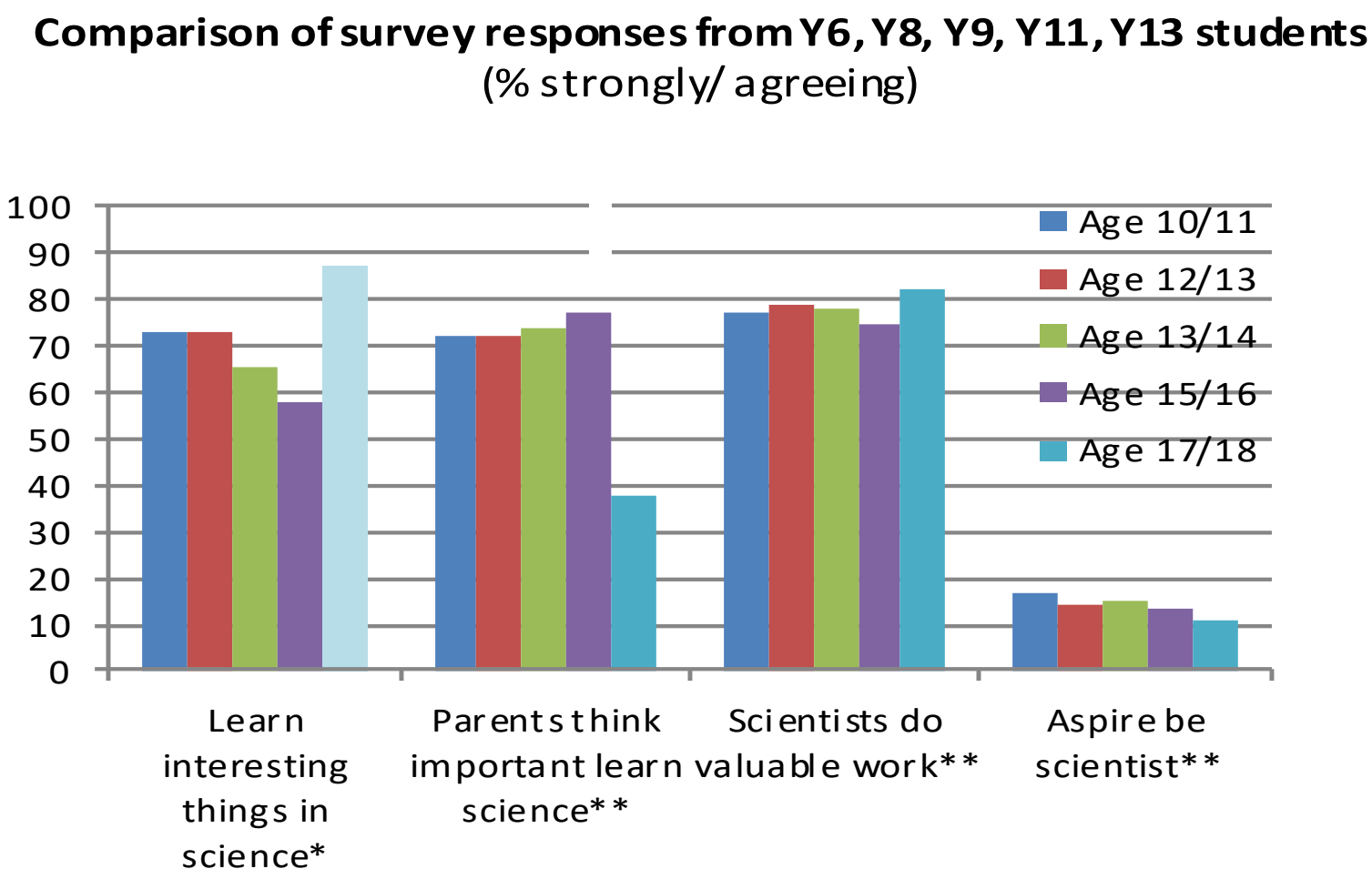
Policy Context

- Lots of time and money has been invested in efforts designed to engage more young people with science
- But little change in participation rates and participation profile – which remains narrow/privileged
- Many efforts have sought to make science more ‘fun’ and ‘interesting
- But lack of interest is not the main problem …

ASPIRES research

- Since 2009 the ASPIRES project has undertaken large-scale surveys (40,000+ young people to date), and in-depth tracking of 50 students and their parents (age 10-21) (700+ interviews)
- Student surveys and interviews at ages 10/11 (Y6), 12/13 (Y8), 13/14 (Y9), 15/16 (Y11), 17/18 (Y13) and age 20/21
- Lack of interest in science is not the main issue …

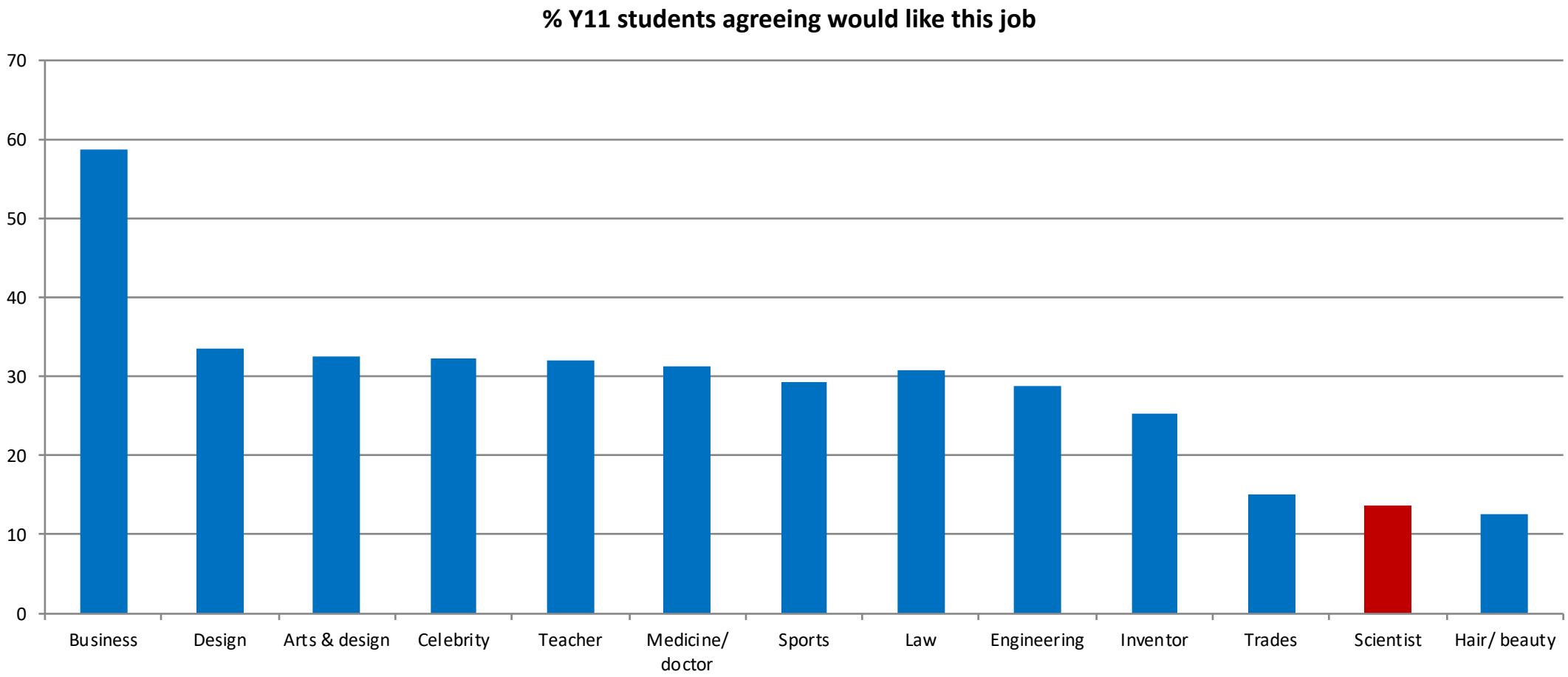
Most like science - but few aspire to be scientists



* Only asked of Y13 students studying at least one science A level

** Y13 data is weighted to national A level science entries

What careers do students aspire to?



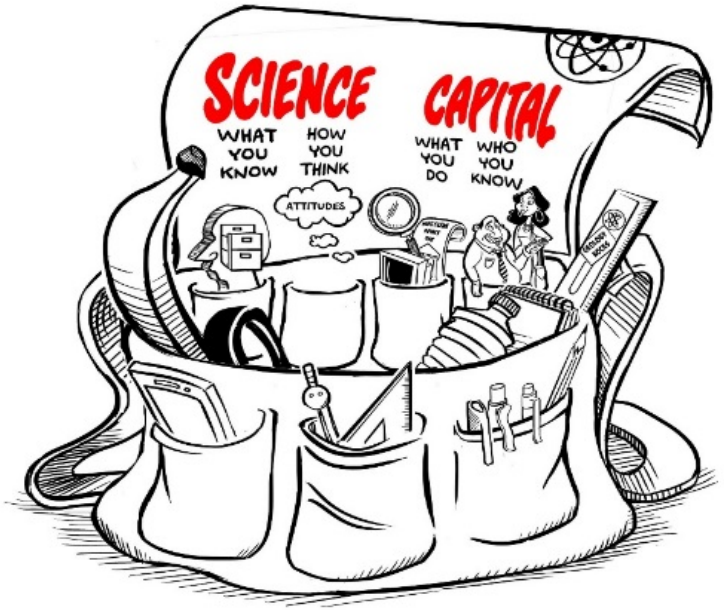
Key factors shaping science aspirations and participation age 10-19

ASPIRES
science and career aspirations: age 10-23

Full (2019) report:
https://discovery.ucl.ac.uk/id/eprint/10092041/15/Moote_9538%20UCL%20Aspires%202%20report%20full%20online%20version.pdf

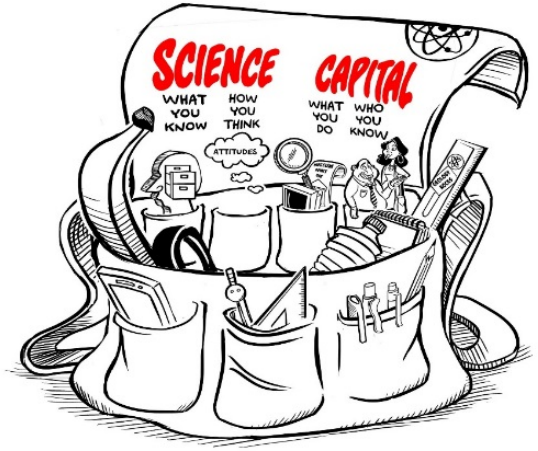
Science capital – what is it?

- Developed in Aspires project and extended in Enterprising Science project
- ‘Science capital’ is a ‘conceptual holdall’, combining habitus, cultural and social forms of capital
- Nationally, about 5% of 11-15 year olds have “high” science capital and 27% “low” science capital
- The more science capital a student has, the more likely they are to aspire to and participate in post-16 science and have a ‘science identity’

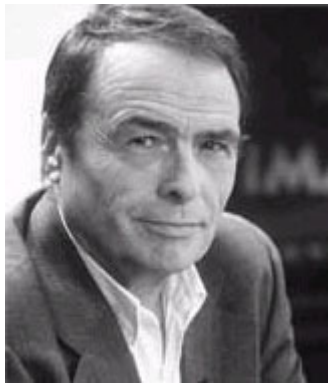


Main dimensions of science capital

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”)



A sociological lens

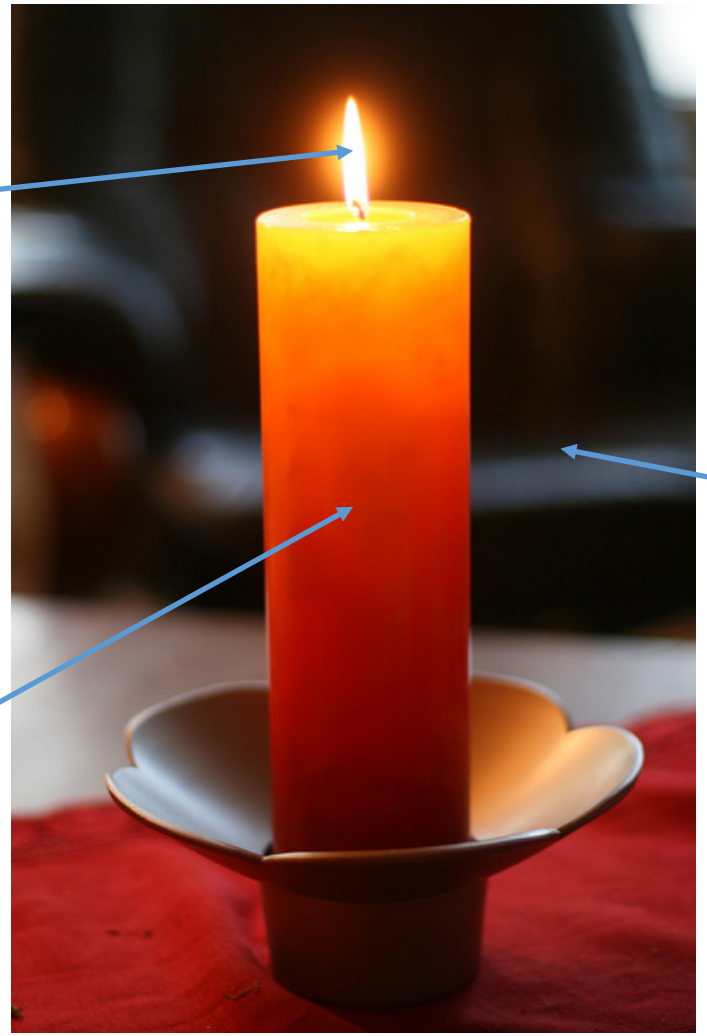


Interactions of *habitus*, *capital* and *field* produce patterns in science engagement and participation:

- ***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

An analogy



Teacher = heat

ENGAGEMENT = burning flame (produced at interface of habitus, capital and field)

FIELD = air and conditions around the candle (oxygen, wind, etc) Influences if and how the candle burns (e.g. how bright, how long, flickering or steady)

HABITUS & CAPITAL = candle ('fuel'): socialised dispositions, and (science-related) economic, social and cultural resources

‘High’ and ‘low’ science capital families

- A note on terminology (“high”/ “low”) and dangers of deficit interpretations
- 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, white middle class).
>
> “Science is just where it’s at in my family” (Davina, white, middle-class)
>
> “I suppose in everyday life you don’t get that much to do with it [science]” (Mother, white, working class)
>
> “They never talk about science” (Jack, Black, working-class)

The field – supporting or limiting the realisation of science capital

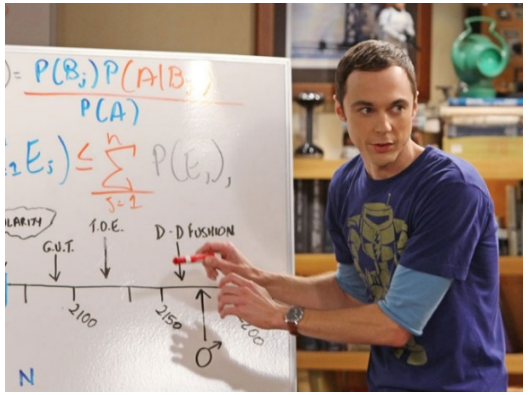
- Value of a person's science capital is determined by the field
- Different fields provide different affordances (or limitations) for young people to see themselves and be recognised by others for their science engagement (e.g. Carlone study of a US middle-school class over time)

- Field plays key part in cultivation of science capital over time and creates the feel for whether 'science is for me' or not
- Bound up with association of science with 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"

As a result …

- Many, even highly interested, young people are stopped/hindered in continuing with science
- Many self-exclude (“science is interesting, but not for me”)
- Those who continue are the most stereotypical in their views of science …



Influence of science capital

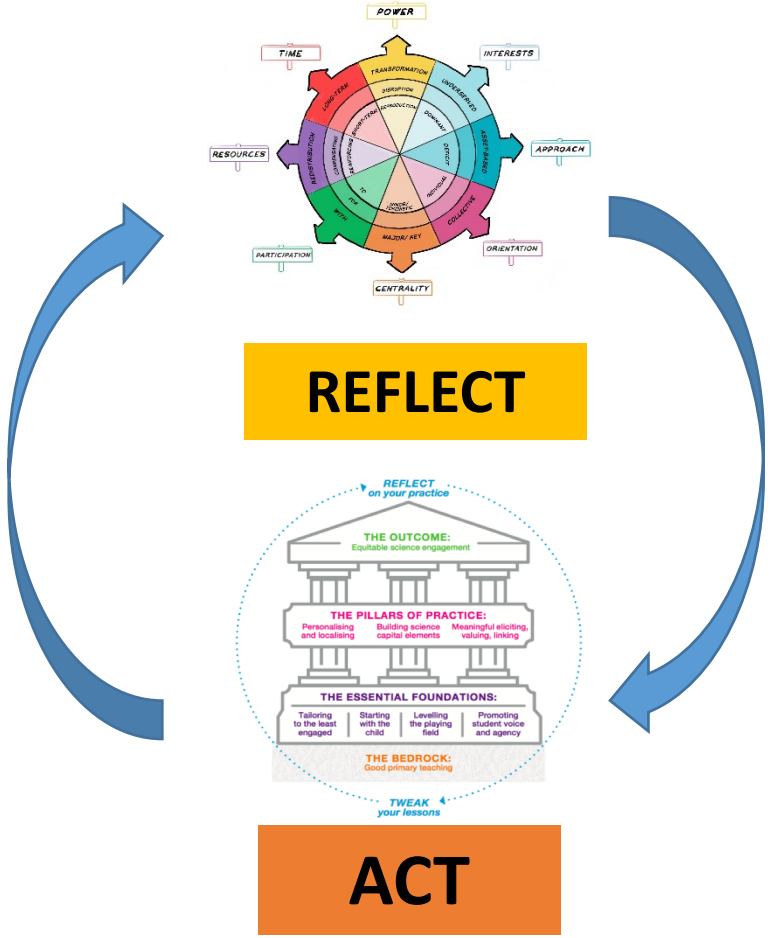
- Useful explanatory concept for entrenched participation patterns
- ASPIRES longitudinal sample: 80% of those who never aspired to science had low science capital. 83% of those who continued post-18 had high science capital
- Students with high science capital are more likely to express positive views of all STEM areas and aspire to continue with STEM
- Science capital is particularly predictive of participation in physics (high SC 7.8x more likely) and engineering (3.2x more likely) but less strongly related to maths and computing
- But is still one factor among many

What can a Science Capital approach offer STEM outreach and public engagement work?

- Framework for understanding issues of differential engagement
- A reflection tool for informing practice
- An evidence-based, pedagogical framework (“the science capital teaching approach”) for building science capital

Supporting ISL engagement

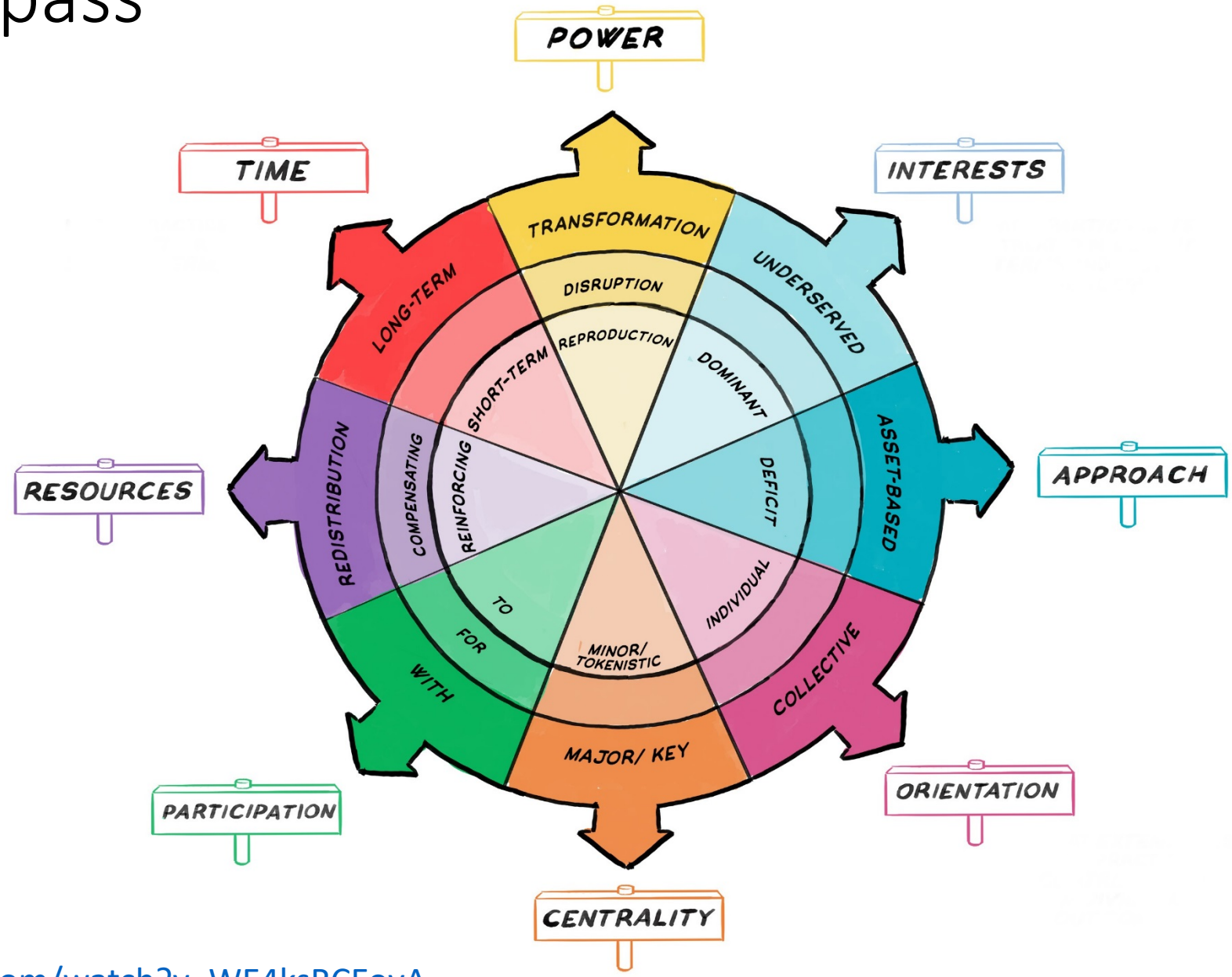
- Its not (just) what you do - but the way that you do it!
- Underpinning values and mind set will determine the equitable potential of your practice and use of the SCTA
- Two elements: the Compass and the Model



Youth Equity+STEM project

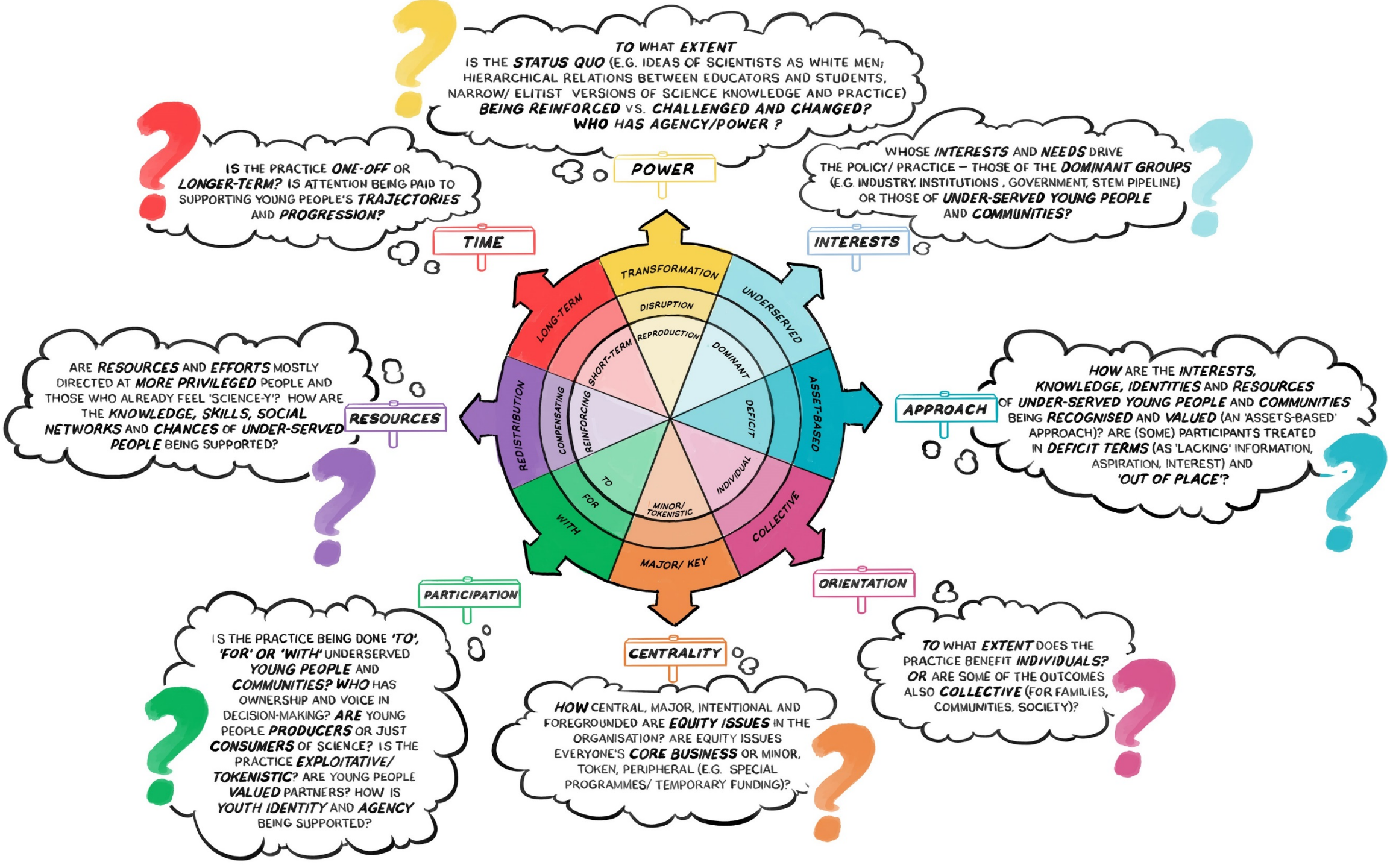
- Four year UK/US project
- Funded by Wellcome Trust, ESRC and National Science Foundation
- Focus on **equity** in informal STEM learning (designed & community) settings
- Focus on young people aged 11-14 from under-served communities
- Participatory working between youth, practitioners and researchers
- Eight ISL partners (3 x science centres, 3 x STEM clubs, community zoo, digital arts centre)

Equity Compass



https://www.youtube.com/watch?v=WE4ksRCEoyA

YOUTH EQUITY + STEM


TO WHAT EXTENT IS THE STATUS QUO (E.G. IDEAS OF SCIENTISTS AS WHITE MEN; HIERARCHICAL RELATIONS BETWEEN EDUCATORS AND STUDENTS, NARROW/ ELITIST VERSIONS OF SCIENCE KNOWLEDGE AND PRACTICE) BEING REINFORCED VS. CHALLENGED AND CHANGED? WHO HAS AGENCY/POWER ?
POWER
IS THE PRACTICE ONE-OFF OR LONGER-TERM? IS ATTENTION BEING PAID TO SUPPORTING YOUNG PEOPLE'S TRAJECTORIES AND PROGRESSION?
TIME
WHOSE INTERESTS AND NEEDS DRIVE THE POLICY/ PRACTICE – THOSE OF THE DOMINANT GROUPS (E.G. INDUSTRY, INSTITUTIONS , GOVERNMENT, STEM PIPELINE) OR THOSE OF UNDER-SERVED YOUNG PEOPLE AND COMMUNITIES?
INTERESTS
TRANSFORMATION
DISRUPTION
REPRODUCTION
LONG-TERM
SHORT-TERM
UNDERSERVED
DOMINANT
REDISTRIBUTION
COMPENSATING
REINFORCING
DEFICIT
ASSET-BASED
TO
FOR
WITH
MINOR/ TOKENISTIC
INDIVIDUAL
COLLECTIVE
MAJOR/ KEY
ARE RESOURCES AND EFFORTS MOSTLY DIRECTED AT MORE PRIVILEGED PEOPLE AND THOSE WHO ALREADY FEEL 'SCIENCE-Y'? HOW ARE THE KNOWLEDGE, SKILLS, SOCIAL NETWORKS AND CHANCES OF UNDER-SERVED PEOPLE BEING SUPPORTED?
RESOURCES
HOW ARE THE INTERESTS, KNOWLEDGE, IDENTITIES AND RESOURCES OF UNDER-SERVED YOUNG PEOPLE AND COMMUNITIES BEING RECOGNISED AND VALUED (AN 'ASSETS-BASED' APPROACH)? ARE (SOME) PARTICIPANTS TREATED IN DEFICIT TERMS (AS 'LACKING' INFORMATION, ASPIRATION, INTEREST) AND 'OUT OF PLACE'?
APPROACH
IS THE PRACTICE BEING DONE 'TO', 'FOR' OR 'WITH' UNDERSERVED YOUNG PEOPLE AND COMMUNITIES? WHO HAS OWNERSHIP AND VOICE IN DECISION-MAKING? ARE YOUNG PEOPLE PRODUCERS OR JUST CONSUMERS OF SCIENCE? IS THE PRACTICE EXPLOITATIVE/ TOKENISTIC? ARE YOUNG PEOPLE VALUED PARTNERS? HOW IS YOUTH IDENTITY AND AGENCY BEING SUPPORTED?
PARTICIPATION
HOW CENTRAL, MAJOR, INTENTIONAL AND FOREGROUNDED ARE EQUITY ISSUES IN THE ORGANISATION? ARE EQUITY ISSUES EVERYONE'S CORE BUSINESS OR MINOR, TOKEN, PERIPHERAL (E.G. SPECIAL PROGRAMMES/ TEMPORARY FUNDING)?
CENTRALITY
TO WHAT EXTENT DOES THE PRACTICE BENEFIT INDIVIDUALS? OR ARE SOME OF THE OUTCOMES ALSO COLLECTIVE (FOR FAMILIES, COMMUNITIES, SOCIETY)?
ORIENTATION

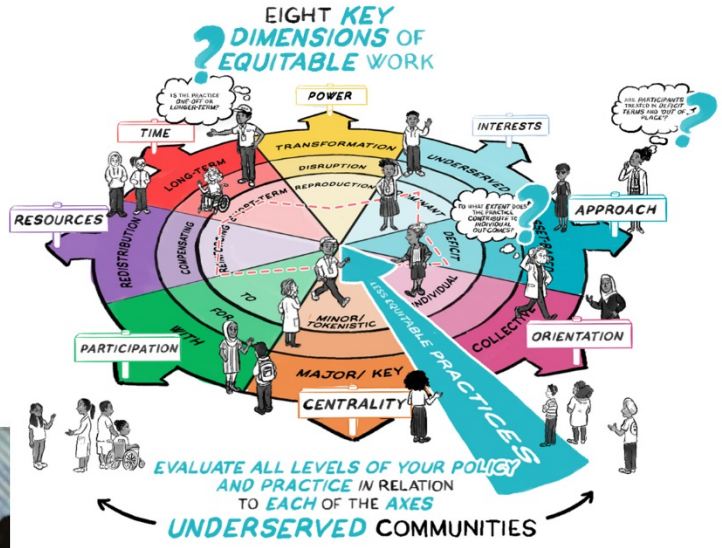
- 2 minute explanatory animation:

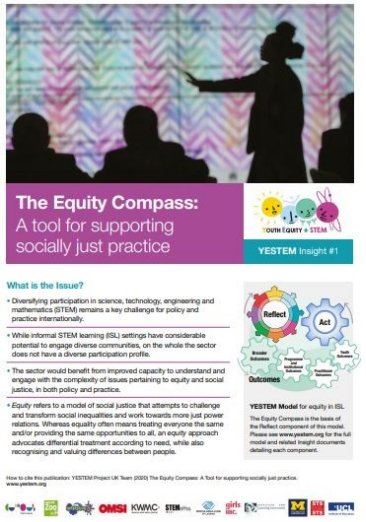
https://www.youtube.com/watch?v=WE4ksRCEoyA

- Summary publication for practitioners

http://yestem.org/wp-content/uploads/2020/10/EQUITY-COMPASS-YESTEM-INSIGHT.pdf

- Applying with ISL educators (YESTEM project) and primary teachers (Primary Science Capital Teaching Approach project)





YOUTH EQUITY + STEM

Compass helps us to:

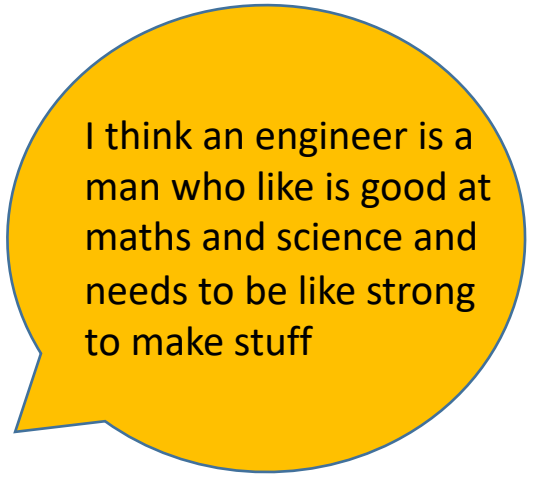
- Recognise and think about 8 key dimensions of equity/ social justice
- Use reflective questions to guide our thinking
- Consider how equitable practices and outcomes are
- Map where we are – and map our progress (moving from inside outwards)

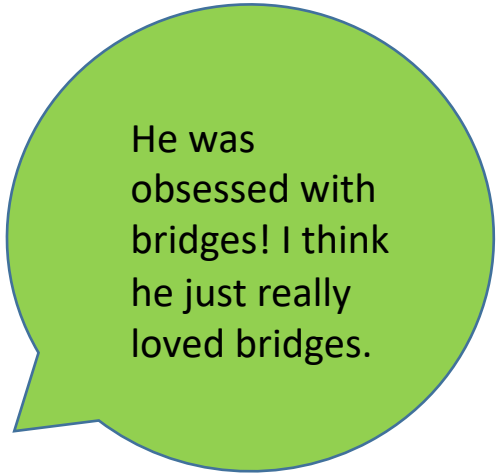
Example: “Dr. Bridges”

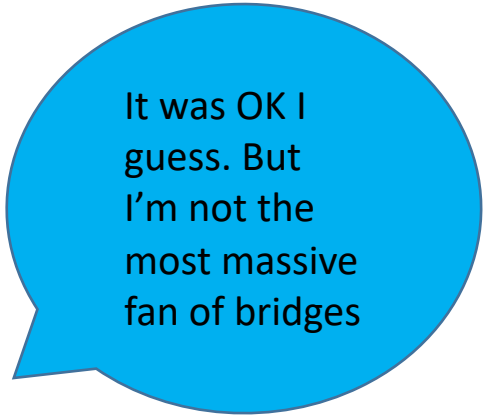
- Visiting STEM professional doing one-off session with Y4 class
- Tells class a bit about his job
- “Can anyone describe what a bridge is?” Children give ideas
- Short powerpoint talk about the importance of bridges and what maintenance they require
- Tells them arched bridges are much stronger than flat bridges
- Runs hands-on lolly stick bridge activity – tells children to build one flat bridge and one arched bridge and see how many toy cars are supported on each

Evaluation

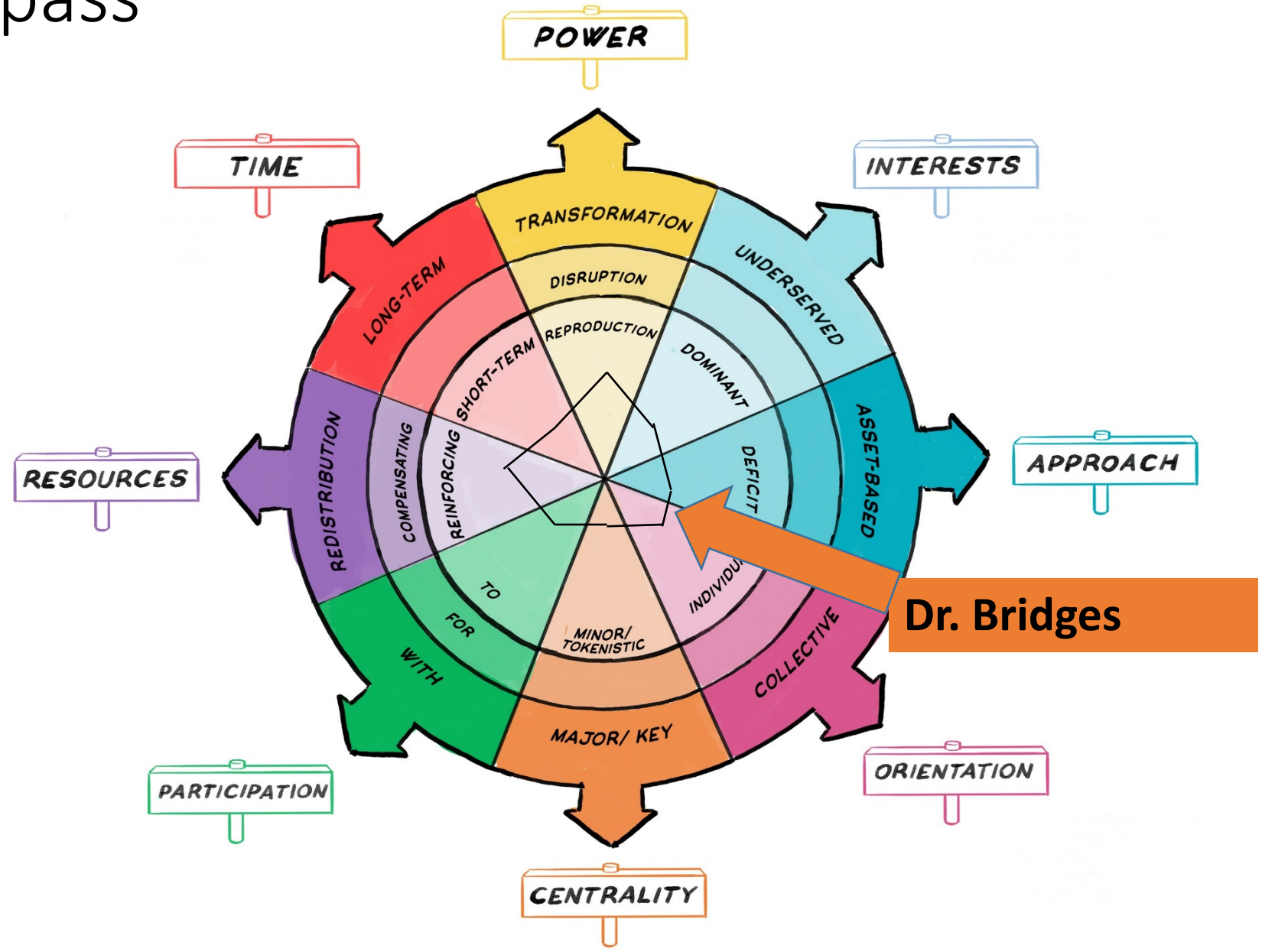
- Plus points: children increase their engineering content knowledge a bit; direct experience of meeting STEM professional; break from norm
- Minus points: children not very engaged or inspired; reinforced, rather than disrupted, existing, dominant power relations and stereotypes (e.g. of engineers/ engineering); did not support children's agency







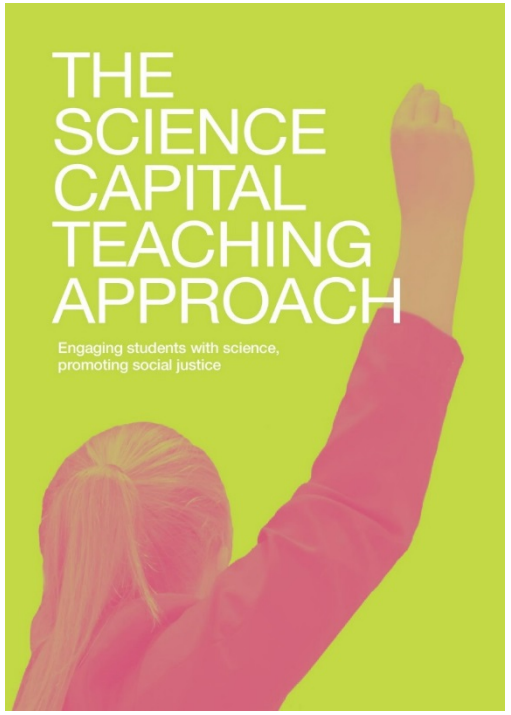
Equity Compass

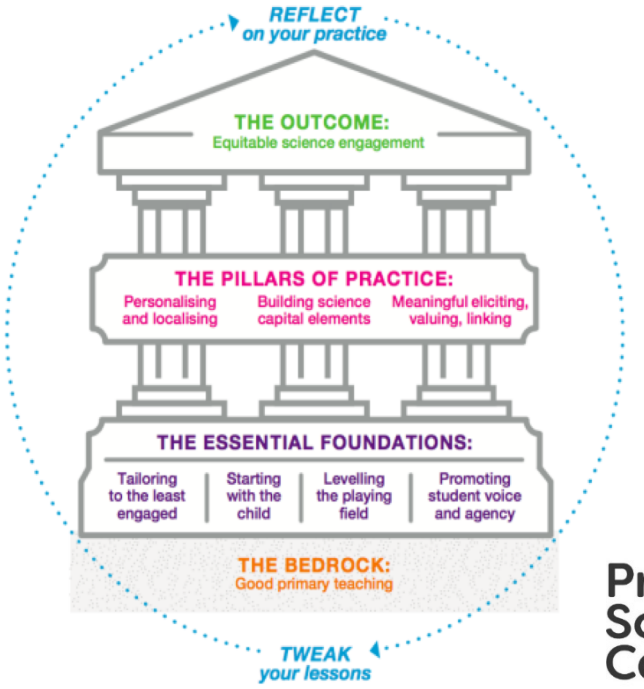


YOUTH EQUITY + STEM

(2) Adopting a science capital approach

Figure 3. A model of factors shaping young people's science identities and aspirations age 10-19.



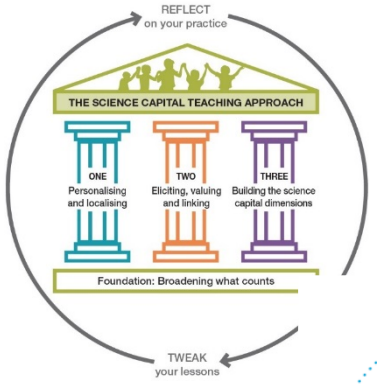


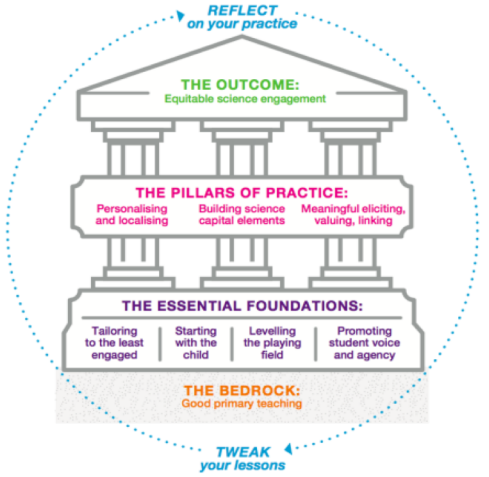
Primary Science Capital

Changing the field (‘air around the candle’)

The Science Capital Teaching Approach

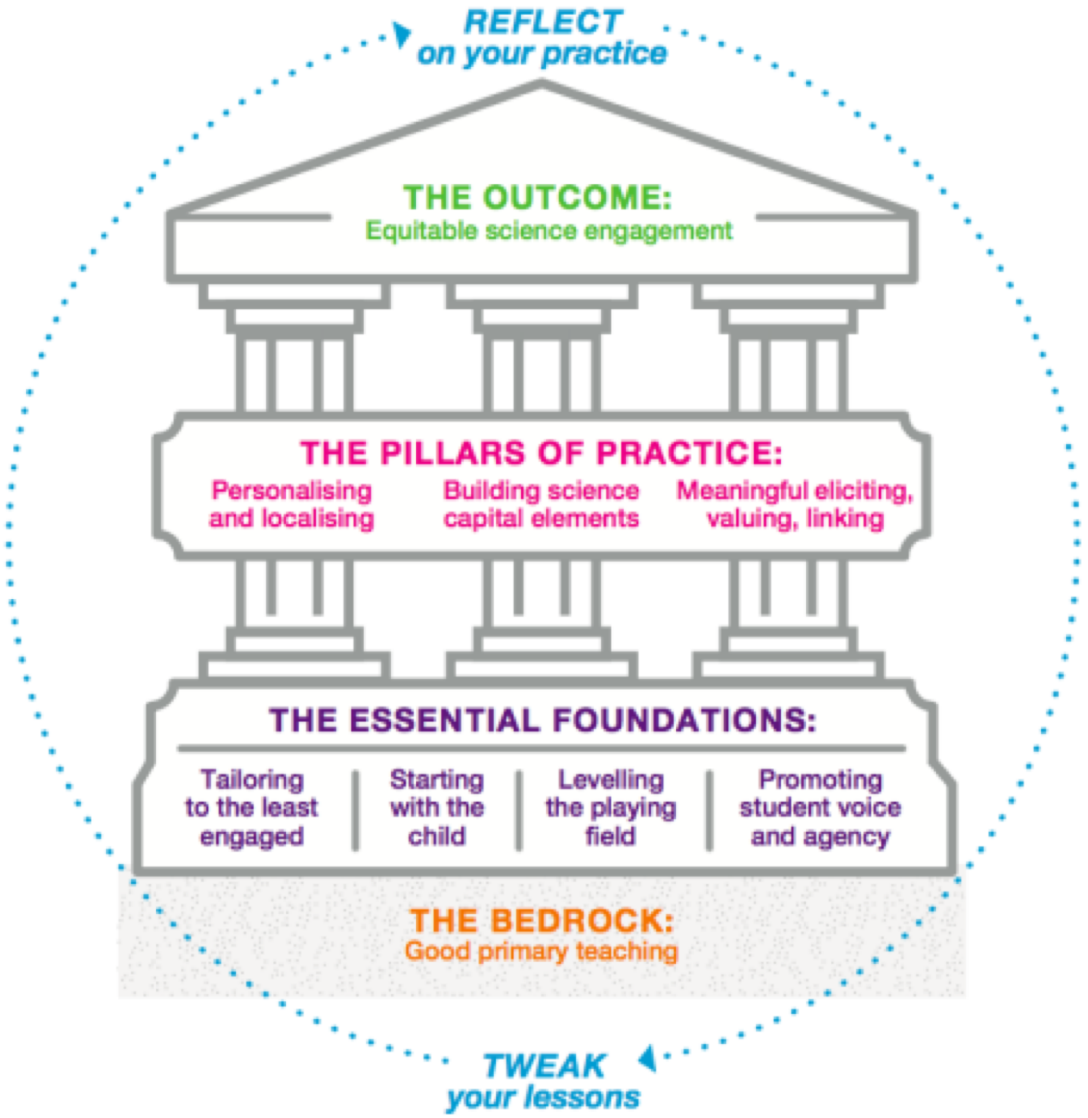
- Social justice approach
- Builds on existing good teaching practice
- Works with any curriculum
- Key principles - improving students’ relationships with science, *changing the field, not the young person*
- Originally developed with secondary (Enterprising Science project), now being developed with primary (PSTT/Ogden project) and with the informal sector





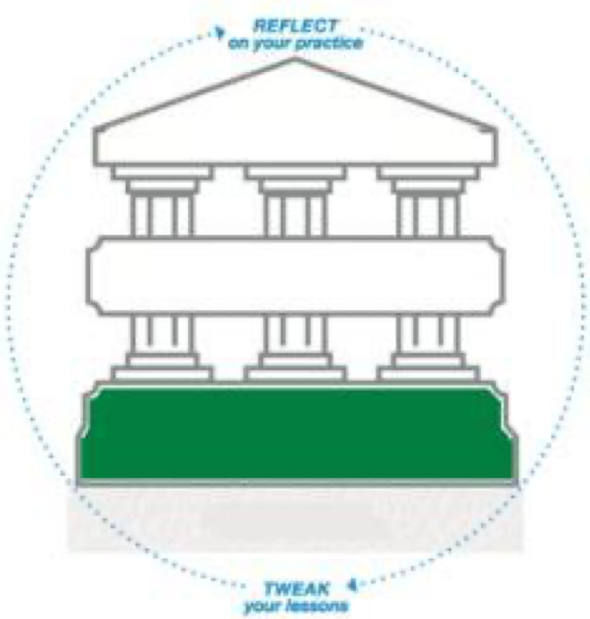
Development of SCTA

- Originated in collaborative R&D work with secondary schools (over 4 years with 40+ teachers from schools in 4 cities)
- Evidence from 2x year long trials showed significant increases in secondary students' science capital, attitudes to science and post-16 science aspirations
- Current project is co-developing the approach with primary teachers
- Also working with informal educators to refine and apply
- 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)

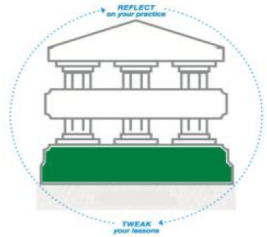

REFLECT
on your practice
THE OUTCOME:
Equitable science engagement
THE PILLARS OF PRACTICE:
Personalising and localising
Building science capital elements
Meaningful eliciting, valuing, linking
THE ESSENTIAL FOUNDATIONS:
Tailoring to the least engaged
Starting with the child
Levelling the playing field
Promoting student voice and agency
THE BEDROCK:
Good primary teaching
TWEAK
your lessons

Foundation: Broadening what counts

- Young people do not just find science concepts difficult – some struggle to identify and engage with science, it feels alien to them
- Challenge stereotypes and dominant ideas and representations of science, such as ‘who does science’ and what constitutes ‘doing’ science



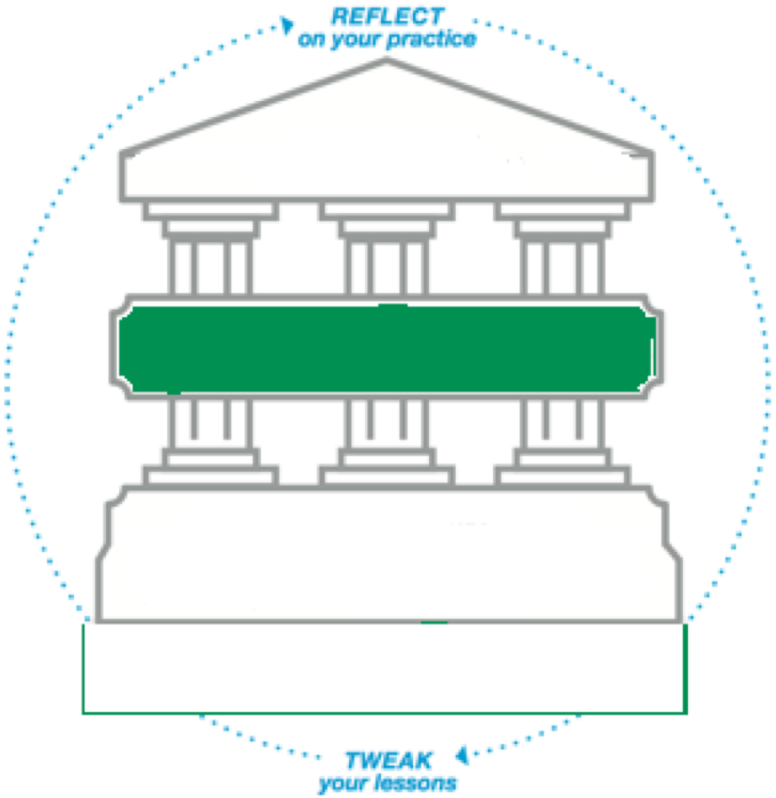
Foundation: Broadening what counts



Tailoring to the least engaged	Start with/ centre the participant	Levelling the playing field	Supporting voice and agency
Plan sessions from the perspective of a young person who seems often to not be very engaged and think about ways to make science more relatable for them	*Instead of planning and starting a session from the point of view of a learning objective, start with what participants already know/ care about/ have experienced and how/why it might relate to their lives and what is important to them*	*Create a learning environment where participants who do not have certain resources are not unnecessarily disadvantaged. Value wider ways of 'doing science'*	*Create a learning environment where young people's voices are heard and validated. Use their voices to direct the experience so that participants have ownership/agency towards the science topics, organisation and style of learning*

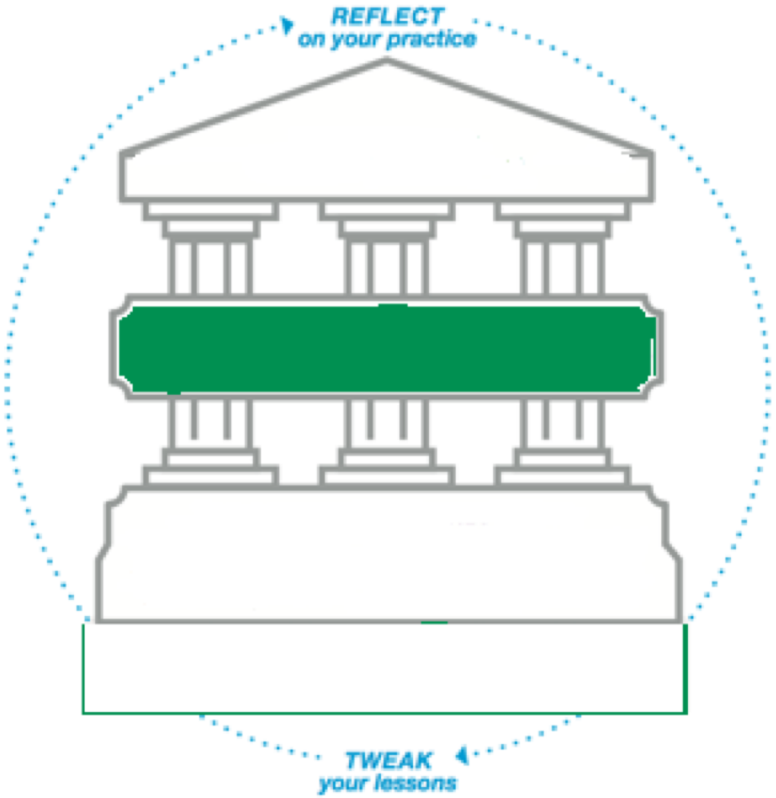
Pillar: Meaningfully Elicit, Value & Link

- A technique for helping to broaden what counts and personalise and localise
- Way to support participants to feel valued and connected to science
- Educators elicit participants' experiences, skills and home and cultural knowledge (what they 'bring with them') in relation to a topic, value (and legitimate) these, and highlight the science connections

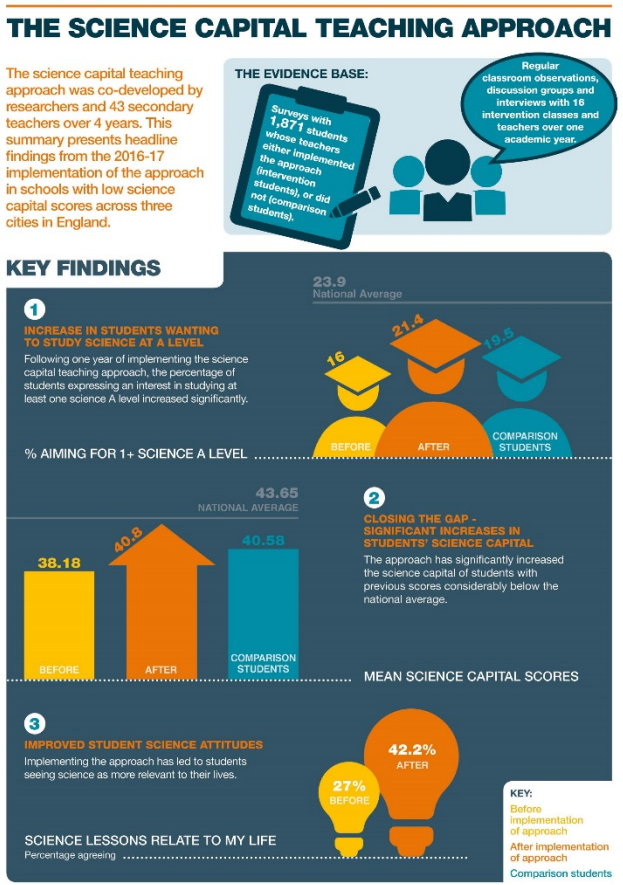


Pillar: Building the science capital dimensions

- Actively cultivate, develop and build science capital dimensions
- E.g. build understanding of how science is everywhere in life; foster the sense that science isn't hard, or for other people, but can be a part of everyone's life and conversations.



Outcomes - secondary



Key features

- Approach has proved popular across primary, secondary and informal settings
- Trying to help move the focus away from ‘more STEM’ (esp. content knowledge), one-offs, deficit approaches
- Key to approach is embedding SC principles in *everyday* practice
- One-off visits have a place, but will not be as effective as participatory, focused, longer-term engagement.
- Using SCTA to support and develop young people’ critical STEM agency – taking action on issues that matter to them and their communities
- In conjunction with the social justice mind set (Compass)

Summing up

- The compass and SCTA can help us think about and enact equitable/socially just STEM engagement practice and help STEM and young people to more meaningfully connect
- Key point: changing practice (the field), not the young person
- Together, the resources provide tools for practice and can help track progress and support professional reflection and development
- Our projects will be publishing a range of resources, publications, etc., for the ISL sector over the coming year


THANK YOU


Any questions?

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

Some further SCTA resources

- Archer, L., Nomikou, E., Mau, A., King, H., Godec, S., DeWitt, J., & Dawson, E. (2018 - online). Can the subaltern 'speak' science? An intersectional analysis of performances of 'talking science through muscular intellect' by 'subaltern' students in UK urban secondary science classrooms. Cultural Studies of Science Education. DOI: 10.1007/s11422-018-9870-4.
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