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INCLUSIVE SCIENCE
TEACHING AND LEARNING (ISTL)

Identifying the factors that influence disadvantaged pupils and students to engage effectively in science learning and qualifications (post-pandemic).

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ABOUT THIS STUDY

RATIONALE AND CONTEXT

The Faculty of Science & Engineering relies on a pipeline of inspired researchers, lecturers and support staff in strategic growth areas. The STEM (Science, Technology, Engineering & Maths) pipeline starts well before students enter the university. Aspirations and career choices are made from an early age, supported by teaching and careers advice in schools.

This short study focuses on developing understanding about our student population and their needs, and in particular those students who are influenced by 'educational disadvantage'. By speaking with STEM teachers from primary, secondary, Further and Higher Education phases, the study aims to reflect their real experiences of supporting educationally disadvantaged pupils and students to engage in STEM learning. The study builds on the *Shining a light on inclusive science teaching and learning (7-14 years)* report (Bianchi & Turford, 2021), by highlighting four contextual dimensions that may be considered to influence progression and success for learners across the STEM pipeline.

The ultimate goal is to further enhance inclusive teaching, learning and assessment in STEM education. This report offers a richer understanding of the factors that influence our students before and during their University learning journey. The authors invite you to consider the findings of this study, and to reflect on strategic and operational changes that could further improve the experiences of all students, with particular emphasis on our Widening Participation students.

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USING THIS REPORT

TEACHING AND TEACHING-SUPPORT STAFF

Teaching and teaching-support staff may use this report to reflect on individual practice and to inspire discussion with colleagues. The report provides useful stimulus to share personal experiences, to develop ideas and to become increasingly open about our pedagogy as a community of teaching professionals.

Key questions to consider:

- How does my experience compare to that of others?

- Which aspects of this report could I consider in the short-term and long-term that could positively influence students' STEM learning experience?

LEADERSHIP TEAMS

Leadership teams may use this report to inform strategic discussions about the student experience, and in particular how Widening Participation students can be further supported in their learning.

Key questions to consider:

- How does the experience and perspective of students and academics in our department compare to those reflected in this study?

- How do we further explore the effectiveness of our inclusive teaching approaches and how is best-practice being cascaded across our department?

STUDENTS

Students may use this report to support their own reflections on their experiences before and during their University course. It may support them to open up a dialogue with academic advisors, support staff or peers to share their experiences and viewpoints about inclusion in STEM learning.

Key questions to consider:

- What factors regularly impact on my STEM learning experience?

- How, where and when may I be able to gain support and advice about my learning and progression at University?

KEY TERMS

EDUCATIONAL DISADVANTAGE

Educational disadvantage is when some individuals get less benefit from the education system than their peers. The Education Act 1998 defined educational disadvantage as 'the impediments to education arising from social or economic disadvantage which prevent students from deriving appropriate benefit from education in schools. Educational disadvantage can be demonstrated in a range of ways, most often in poor levels of participation and achievement in the formal education system. Other ways in which children may be disadvantaged is as a result of a disability, literacy difficulties, ill health or poverty.

PUPIL PREMIUM (PP)

Pupil Premium is a form of funding provided by the Department of Education to improve education outcomes for disadvantaged pupils in mainstream schools in England. Evidence shows that disadvantaged children generally face additional challenges in reaching their potential at school and often do not perform as well as other pupils.

The Pupil Premium was introduced in 2011 to increase social mobility and reduce the gap in performance between pupils from disadvantaged backgrounds and their peers. Schools receive funding for each disadvantaged pupil and can use the funding flexibly, in the best interests of eligible pupils.

WIDENING PARTICIPATION (WP)

Widening Participation refers to the work done in education to increase the number of young people entering Higher Education. It seeks to address patterns of underrepresentation.

TIMELINE OF THE STUDY – 2022

MARCH

Ethical Approval
[Ref: 2022-12913-24154]
Faculty Survey

APRIL

Participant recruitment
from SEERIH
partnership schools
and colleges, University
departments
Participant briefing
and consent

MAY-JUNE

12 semi -structured
interviews on concepts
of disadvantage in
STEM learning –
2 primary, 2 secondary,
2 Further Education
and 6 Higher Education
teachers/lecturers

JULY-AUGUST

Data analysis
and collaboration

SEPTEMBER

Report writing
and dissemination

QUALITATIVE DATA ANALYSIS

Informed by

Opfer, V.D. and Pedder, D. (2011) to review teacher learning, values and beliefs and the impact that learning experiences have on their knowledge and changes in classroom practices.

FIRST ORDER ANALYSIS
Informed by Pedder & Opfer (2011)

Identification of analytical framework and formulation of coding plan to structure analysis of survey and interview data. Improving consistency across two coders.

SORTING DATA USING THE ANALYTICAL FRAMEWORK

Labelling and reducing data into groups. Coder cross validation of grouping.

DESCRIPTIVE ANALYSIS

Development of initial codes.

SECOND ORDER ANALYSIS
Informed by Ball, Maguire & Braun (2012)

Identification of and consolidation of themes and patterns in the data, towards report writing.

OUTCOMES

Two forms of analysis were undertaken to derive understanding for the survey and interview data.

FIRST ORDER ANALYSIS

Identified the factors that influence educational disadvantage at different levels of the education system (from primary through to Higher Education). The table shows three levels of influence - micro, meso and macro. The descriptions list the factors that impact on the learning experience of young people experiencing educational disadvantage. The lists are non-exhaustive and open to professional debate and discussion.

System level	Description
Macro Level Local, national and international policies and enactments	**Policy drivers in schools** · Pupil Premium · DfE Disadvantage **Policy drivers in Higher Education** · Widening Participation · Educational Maintenance Allowance (EMA)
Meso Level School, institutional structures and practices	· Teacher quality – expertise, stability, CPD · External partnerships and engagement – employers, HEIs, Learned Societies · Practical resources, e.g. labs/facilities, computers · Pastoral support – student welfare, well-being, careers · Data management – identifying pupils below potential, interventions · Significant others – form tutors, mentors, role models · School leadership – inclusive culture, wider communities, innovation · Collaborations – students/teachers/parents/family/carers
Micro Level Teachers, students, classrooms, and pedagogy	· Literacy, language and cultural boundaries · Teacher aspirations, expectations and career knowledge · 'Eyes on the next level' – curriculum progression, pathways. · Pedagogy – active, blended learning, enquiry based learning, problem solving · Teacher values and attitudes (unconscious bias) · Social and sustainable interactions between schools, teachers and students · Mentors and role models · Work/life imbalance – caring requirements; more than one home; jobs; digital assets · Good interpersonal skills – character, resilience, ability to work in groups, problem solving, self management · Lack of readiness for exams

SECOND ORDER ANALYSIS –

EMERGING THEMES AS CONTEXTUAL DIMENSIONS

In-depth analysis of interview data identified common themes and patterns that were considered to affect disadvantaged learners' experiences and engagement in STEM education. These are represented in this report as interrelated and contextual dimensions informed by key thinkers and actors in education policy.

Four contextual dimensions are represented:
- socio-economic
- cultural
- material
- external

SOCIO-ECONOMIC CONTEXT
Home background, experiences, status

EXTERNAL CONTEXT
HE/school status, legal requirements, policy

CULTURAL CONTEXT
Attitudes, values, ethos, norms

MATERIAL CONTEXT
Budgets, buildings, technology, infrastructure
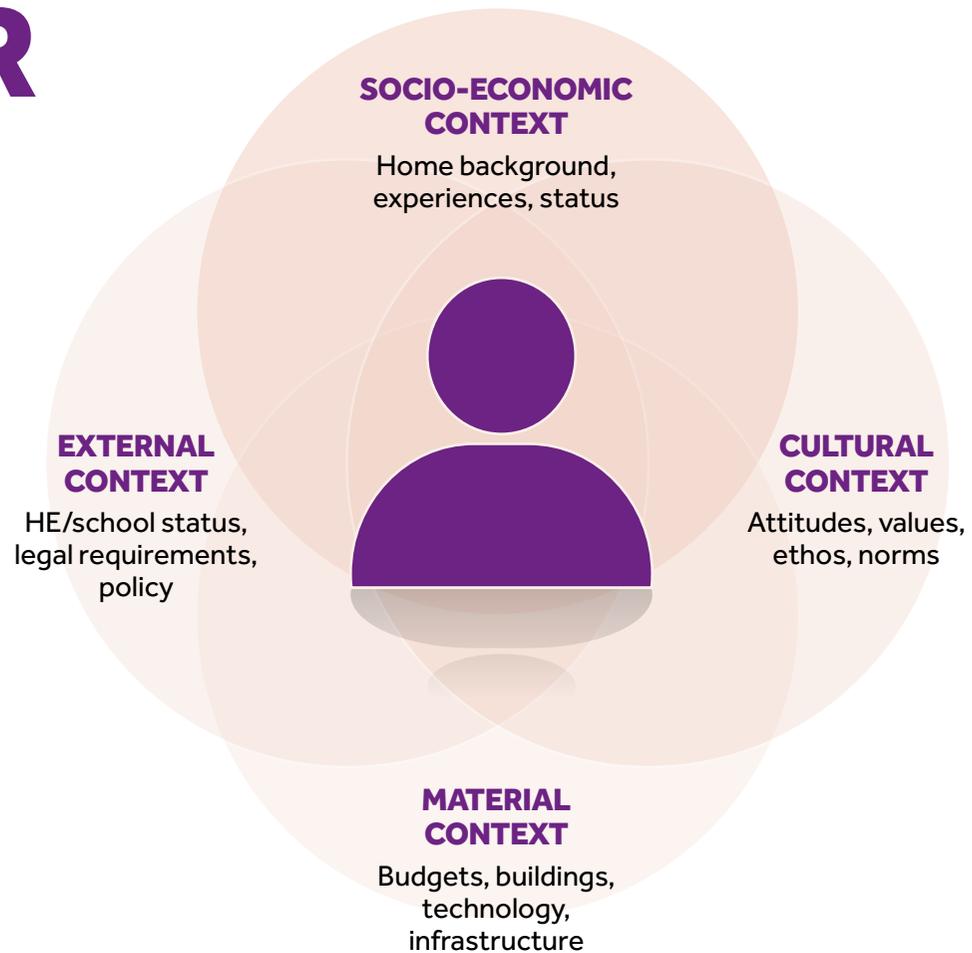
Each dimension is reported in more detail, bringing together key quotes from interviewees and suggested further reading.

DIMENSION 1
SOCIOECONOMIC CONTEXT

Home background, experiences, status
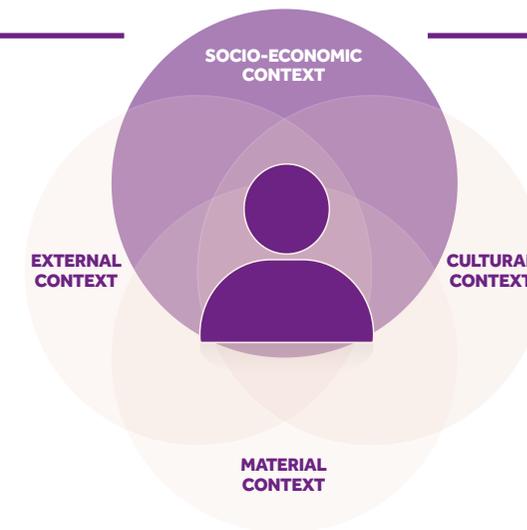
> "
> *There are some students who have a late shift at work... or they have two to three bus travels and so are late to school... sometimes we will find these students can't properly engage with the lesson.*
> **Post 16 Science Teacher**
>
> *They have not been trained in exam skills in the same way as someone whose been to a private school or a grammar school.*
> **HE Lecturer**
> "

OVERVIEW OF FINDINGS

Socioeconomic context refers to those factors such as family income level, parents' level of education, race and gender, that may influence the quality and availability of education as well as the ability of education to improve life circumstances. In interviews, frequent references were made to the low levels of literacy and numeracy of the parents of disadvantaged learners. In addition, the teachers described the challenges parents and carers faced during the pandemic, being unsure of how to support their children's learning at home.

Interviewees also referred to historical and locationally-linked factors that influenced students' learning, for example the school catchment area and demographic of student intake. Teachers and lecturers often referred to the different levels of student 'assessment readiness', noting that those from low income homes were found to have less parental support for their studies, limited space for learning at home and fewer learning resources.

A common concern emerging from the interviews related to the disadvantage experienced by students who were older siblings in families. They described the impact of the requirement for them to act as a carer and the responsibility they had beyond their studies. Many explained of the need for students to bring income into the household whilst studying, and often HE students were working whilst studying, potentially with more than one job.

Interviewees explained that students from higher income families had more experiences to consider going to University, with more awareness within the family about what this involved.

Further reading: Blandford, S. (2017). *Born to Fail? Social Mobility, A working class view.* John Catt Educational Ltd.

DIMENSION 2
CULTURAL CONTEXT

Attitudes, values, ethos, norms

> " *They might feel out of place, and that might have an impact on their willingness to discuss difficulties...I expect students who come from educationally disadvantaged backgrounds to be more self conscious in general and not wanting to draw attention to themselves.* **HE Lecturer**
>
> *A lot of students don't have good experiences for developing background knowledge that other students, whose parents talk to them about anything – like science, would have.* **Primary Teacher**
>
> *I asked an 11 year old pupil to write about a beach and they couldn't as they had experienced a beach.* **Primary Teacher** "

OVERVIEW OF FINDINGS

Culture refers to less tangible variables that consider individual and community values, ethos, attitudes and commitments and how they may shape and influence students' engagement and learning. Schools, institutions, communities and families have distinctive cultures, outlooks and aspirations that have evolved over time. Recent research in science education forefronts the notion of *science capital* a concept that helps us to understand and consider why particular social groups remain underrepresented in science/STEM and why many young people do not see science careers as being 'for me'. Teachers repeatedly referred to family values, parental expectations and their aspirations. Comments related to the level of education of parents and in particular, their lack of knowledge of science and associated careers. This is a common finding in the educational research literature. Furthermore, a striking observation, was the many comments related to the capacity and capability of parents to support their childrens' learning during the pandemic.
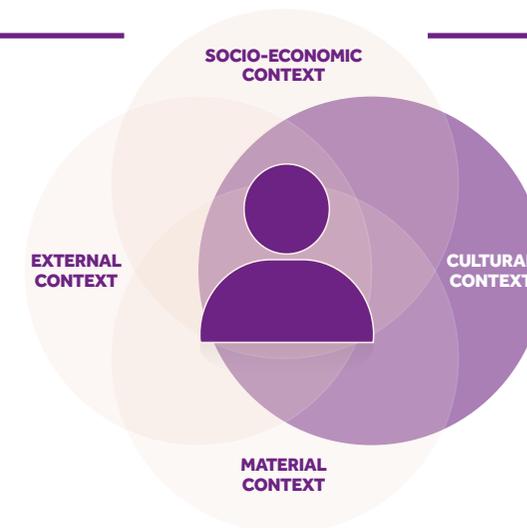
Further reading: Archer, L., DeWitt, J. & Wong, B. (2014). Spheres of influence: what shapes young people's aspirations at age 12/13 and what are the implications for education policy? Journal of Education Policy, 29(1), pp.58–85

Stevenson, J. and Clegg, S. (2011) Possible selves: students orientating themselves towards the future through extracurricular activity. British Educational Research Journal, 37 (2) 231-246

SOCIO-ECONOMIC CONTEXT

EXTERNAL CONTEXT

CULTURAL CONTEXT

MATERIAL CONTEXT

DIMENSION 3
MATERIAL CONTEXT

Budgets, buildings, technology, infrastructure

SOCIO-ECONOMIC CONTEXT

EXTERNAL CONTEXT

CULTURAL CONTEXT

MATERIAL CONTEXT

> "
>
> *They can't pay for good laptops. I have had students who cant even download the Uni handbook because the computer does not have enough memory.* **HE Lecturer**
>
> ....
>
> *Some of our pupils are in a house of five kids and one computer and the majority of the work was online... We do try to accommodate and hand out laptops, but some did not take the help that was provided. Communication with parents is difficult, some don't always want to be contacted.* **Secondary Science Teacher**
>
> ....
>
> *I am lucky as I have science as a degree... but for a lot of teachers, they don't have that background and a few of our teachers will struggle to deliver the science... and it's hard to enthuse as much.*
> **Primary Teacher**
>
> "

OVERVIEW OF FINDINGS

In this study, we are referring to the **material contexts** such as resources for teaching and learning, which includes access to basic materials such as pens, paper, folders as well as access to laboratories, practical equipment and to high quality teaching and subject expertise. A sixth form science teacher spoke about his concern, that several of their able students were at a disadvantage from the outset of their A Level studies as they simply did not have the funds to buy folders or to print off resources.

During the pandemic there were reports of significant disadvantages for older students, in particular, who had limited or no access to digital devices such as computers, with secure and sustained internet access.
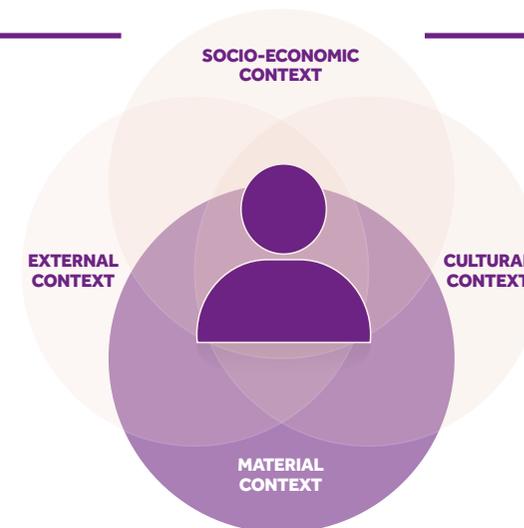
In several cases, interviewees explained how their schools had catered for this need yet reported that support was often not accessed by the students, and that sustaining communication with parents and carers added to the challenge. At HE level, the lack of resourcing of schools and colleges for practical work was reported as potentially hampering progress and affecting UG starting points. Sixth form teachers and lecturers both commented on the amount of paid employment that their students were undertaking whilst studying full time and the competing demands that this placed on their students.

DIMENSION 4
EXTERNAL CONTEXT

HE/school status, legal requirements, policy
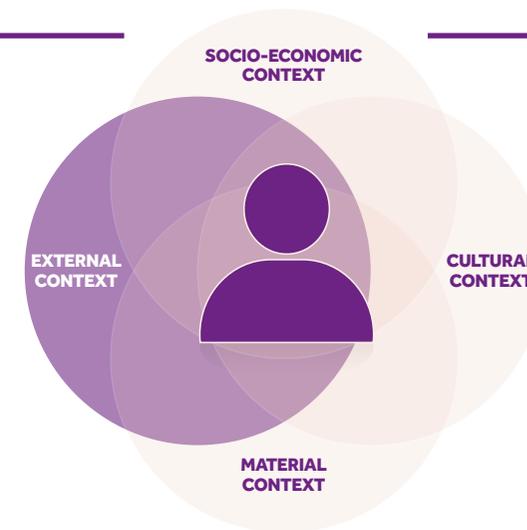
> " In certain types of schools they want to meet their metrics of people going to university, or red brick universities, in other schools they are struggling to make sure people get 5 GCSEs. **HE Lecturer**
>
> Schools try where possible to give these children opportunities for the kinds of things that they might not have access to (e.g.museums). **Primary Teacher**
>
> Enabling people to work with students who are disadvantaged to better understand what the University is about and secondly, they get the help to make appropriate applications.
> **Post-16 FE Lecturer** "

OVERVIEW OF FINDINGS

As highlighted earlier, from the perspectives of teachers interviewed, there are many factors that appear to be influencing and often driving or hindering student engagement and learning in their subject areas. From an external perspective, primary teachers showed awareness, enthusiasm and appreciation of the outreach and widening participation activities that provide additional opportunities for disadvantaged pupils. Secondary teachers explained how their involvements in University Open Days, links with STEM Ambassadors and school visits were beneficial and that schools are often directing Pupil Premium funding to support participation.

At HE level, however, the nature and influence of the **external** context were different, with lecturers explaining that although many international students were able to afford University fees and as such would not be considered WP - they were disadvantaged in other ways, for instance they had different curriculum provision and coverage or their achievement at A Level was not high enough. However, although this lack of 'UG readiness' was mentioned several times, interviewees acknowledged that the high level of support during the transition from school, through the provision of tailored Foundation Courses and targeted academic support was helping to address this gap. Moreover, university open days were highly valued, as was the opportunity for older students to be inspired by 'role models' who had navigated the complex process of securing a place at university and could describe post-16 progression pathways.

Further reading: Agasisti, T., Avvisati F., Borgonovi, F. & Longobardi, S. (2018). *Academic resilience: what schools and countries do to help disasdvnated students succeed in PISA.* OECD Education Working Paper No 167.

STANDING BACK FROM THE DATA

The study has prompted many questions and opened areas for discussion that can be taken forward. Take time to stop and consider the impact of age on factors affecting the learning experience.

How does the lived experience of students change over time?

PRIMARY   SECONDARY   FURTHER   HIGHER
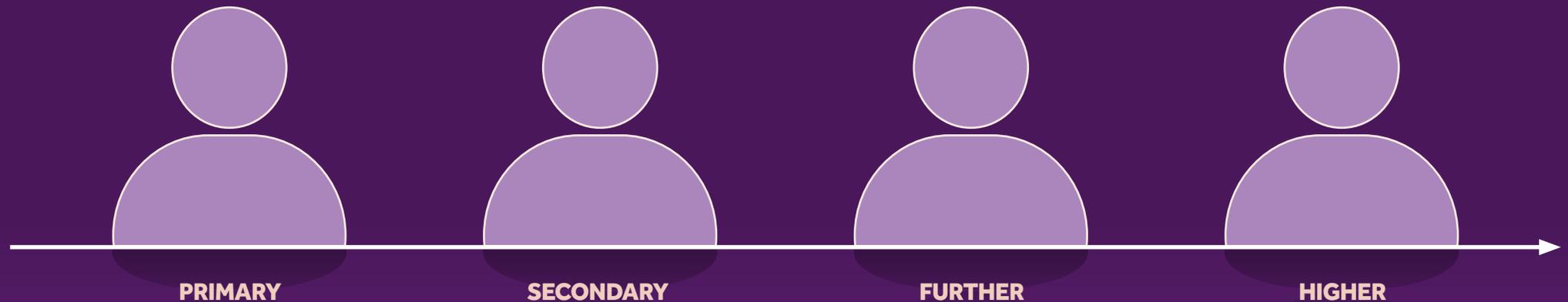
How does parental support and structure change over time? High or Low?

Does the diversity of people that they meet and interact with when learning increase or decrease?

Does the amount of structure within the teaching and learning process change? Highly structured or independent?

How do the class sizes vary across school contexts? Large to small?

ENGAGING EDUCATIONALLY DISADVANTAGED STUDENTS IN STEM LEARNING IN HIGHER EDUCATION – FURTHER QUESTIONS AND RESEARCH

The Faculty of Science & Engineering is committed to maintaining excellence in student experiences. Review and development of our practice with regard to the access and success of our Widening Participation students is ongoing. Question to consider in this process are:

How do we access and use data on our students' background and experience in STEM education?

How can we be more aware and/or take account of the variance in ability in literacy, numeracy or their scientific language/ vocabulary within a STEM student cohort?

In what ways are our STEM students encouraged and supported to develop a sense of community, belonging and agency within our school or institution?

SOCIO-ECONOMIC CONTEXT

EXTERNAL CONTEXT

CULTURAL CONTEXT

MATERIAL CONTEXT

How can we be more aware and/or take account of the variance in ability in literacy, numeracy or their scientific language/ vocabulary within a STEM student cohort?

In what ways are our STEM students encouraged and supported to develop a sense of community, belonging and agency within our school or institution?

How do we become better aware of the financial or resource challenges a STEM student is facing, without being intrusive?

How do we ensure that all our students have equal access to resources and essential learning materials?

FURTHER READING

INTERNAL PUBLICATIONS

FSE Teaching Academy
Factsheet: Inclusive Teaching and Learning
The University of Manchester

The University of Manchester Access & Participation Plan 2020-21 to 2024-25
The University of Manchester

Social responsibility
Faculty of Science and Engineering (StaffNet)
The University of Manchester

Widening Participation webpages
The University of Manchester

Equality & Social Mobility Widening Participation
The University of Manchester

Inclusive Manchester Inclusive Manchester
The University of Manchester

A brief selection of key research papers, policy documents and resources focusing on raising awareness and supporting young people's learning progression into higher education. It is not aimed to provide a comprehensive overview of literature in this area, but to inspire further reading.

Agasisti, T., Avvisati F., Borgonovi, F. & Longobardi, S. (2018). *Academic resilience: what schools and countries do to help disasdvnated students succeed in PISA.* OECD Education Working Paper No 167.

Archer, L., DeWitt, J. & Wong, B. (2014). *Spheres of influence: what shapes young people's aspirations at age 12/13 and what are the implications for education policy?* Journal of Education Policy, 29(1), pp.58–85

Ball, S.J, Maguire, M. and Braun, A. (2012). *How Schools Do Policy: Policy Enactments in Secondary Schools.* Routledge.

Bianchi, L. and Turford, B. (2022). *Shining a light on inclusive science teaching and learning (7-14 years).* The University of Manchester.

Blandford, S. (2017). *Born to Fail? Social Mobility, A working class view. John Catt Educational Ltd.*

Khattab, N. (2015). *Students' aspirations, expectations and school achievement: what really matters?* British Educational Research Journal, 41 (5),731–748

Opfer, V.D. and Pedder, D. (2011). *Conceptualizing Teacher Professional Learning.* Review of Educational Research, 81, 376-407

Stevenson, J. and Clegg, S. (2011). *Possible selves: students orientating themselves towards the future through extracurricular activity.* British Educational Research Journal, 37 (2) 231-246

Summers, R., Higson, H. & Moores, E. (2022). T*he impact of disadvantage on higher education engagement during different delivery modes: a pre- versus peri-pandemic comparison of learning analytics data.* Assessment & Evaluation in Higher Education, DOI: 10.1080/02602938.2021.2024793

Whitty, G., Hayton, A. and Tang, S. (2015). *Who you know, what you know and knowing the ropes: a review of evidence about access to higher education institutions in England.* Review of Education, 3 (1), 27–67

Guide for schools to support their pupil premium strategy
educationendowmentfoundation.org.uk

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career stages;

• Securing and supporting the careers of
researchers and associated professions;

• Diversifying recruitment, reward and
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