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Science and Technology Committee

Diversity and inclusion in STEM

Fifth Report of Session 2022–23

Report, together with formal minutes relating to the report

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Science and Technology Committee

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Summary

STEM—science, technology, engineering and mathematics—provides many of the key building blocks of modern society. Pursuing an interest in it can deliver lifelong benefits given the increasing demand for STEM skills in many areas of the UK workforce.

However, opportunities to gain the skills required by STEM employers are not equally distributed across society. Our inquiry heard evidence that that women, people from certain ethnic backgrounds, people with disabilities, those from disadvantaged socio-economic backgrounds and those who declared themselves as being LGBTQ+ were under-represented in some areas of STEM education, research and employment settings.

The nature of this under-representation varies according to the group and setting, and the reasons it exists are complex. The picture is further complicated by a fragmented approach to the collection and reporting of diversity data across different parts of society and the workforce. This prevents a full understanding of the challenge and hinders well-intentioned efforts to address it. Improved data collection and the application of lessons from it are key to addressing under-representation.

In schools, children's experiences in the classroom shape their life choices and outcomes. In our view, it is important that all children are able to see themselves in what they learn from an early age. A diverse national curriculum—that contains female scientists, for example—is one low-cost way of ensuring this. Similarly, the careers advice and support pupils receive from the earliest years should promote diverse and inclusive role models. Children should see themselves in who they aspire to emulate, as we heard that those who were able to see themselves as scientists or engineers were more likely to pursue the required subjects.

When considering the uptake and attainment in STEM subjects, children from different backgrounds, and different STEM subjects should not be viewed as homogenous groups, as the data at GCSE and A-level indicates. There are differences between boys and girls, with the latter seemingly less inclined to pursue STEM subjects than the former. The evidence our inquiry received offered no consensus as to the reasons for this difference—male dominated-environments, and pre-existing societal expectations being suggested causes. The picture between and within different ethnic and socio-economic backgrounds is similarly complex, however, pupils from some backgrounds, such as Black Caribbean, are clearly underrepresented across STEM subjects at both GCSE and A-level. Others, such as pupils from Chinese backgrounds, are often well-represented.

Access, or the lack of it, to the separate study of biology, chemistry and physics at GCSE—known as the 'triple science' option—is a decisive factor for many pupils in determining whether they pursue the study of STEM subjects beyond the age of 16. If the pool of students studying triple science lacks diversity, this will clearly be reflected in subsequent STEM settings: universities, research facilities, and workplaces.

The Prime Minister has outlined an ambition "to move towards all children studying some form of maths to [age] 18" but has also ruled out compulsion at A-level. We recommend the introduction of a requirement for pupils who do not continue with a STEM subject post–16 to take a Core Maths or a Core Science-type course.

There are benefits to children being taught STEM subjects by teachers with the relevant qualifications or professional experience. The Government should set a target for every child to be taught STEM subjects by teachers with qualifications or experience in that subject by 2030.

There are longstanding challenges with the recruitment and retention of STEM teachers. STEM teacher salaries must be as competitive as possible with the private sector, and the Government's STEM-focused bursaries and other initiatives are to be welcomed. However, according to one contributor to our inquiry, "even if we recruited two thirds of everyone doing a physics degree into teaching, we would only just hit the target" for addressing teacher shortages.

Given this, and the attractiveness of many other jobs requiring STEM degrees, we do not think the amounts currently on offer in the form of bursaries and other payments will prove sufficient to fully address teacher shortages. One way of alleviating the pressure would be to increase the number of Initial Teacher Training recruits with industry experience, and we welcome the Government's nationwide roll-out of a scheme designed in partnership with the engineering sector.

Some STEM academics told us that they have faced discrimination at work—this reflects inequities that exist more widely in society. UK Research and Innovation (UKRI) should further promote diversity and inclusion across the research sector. UKRI should implement processes to determine, monitor, publicly report against, and ultimately meet targets to reduce underrepresentation in funding awards and decision-making bodies.

Ways to improve diversity and inclusion in academia include addressing the precarious nature of many contracts in STEM academia and adopting alternative funding application processes such as narrative CVs. The Government, UKRI and other research funders should also make funding available for research facilities undertaking reasonable adjustments to ensure they are fully accessible for researchers with disabilities.

Improving diversity and inclusion in STEM should be part of the mission of the new Department for Science, Innovation and Technology; and the education and research sectors must follow their lead. This not only reflects the principle of fairness but will ensure the country has access to the best talent available.

1 Introduction

1. STEM—science, technology, engineering and mathematics—provides many of the key building blocks of modern society, and the acquisition and application of STEM skills are increasingly important. Everybody benefits when STEM education, research and employment settings are welcoming, diverse, and inclusive—just as is the case for wider society.

2. Pursuing an interest in STEM can deliver lifelong benefits. A study by London Economics in 2017 found that STEM undergraduate degrees generated larger graduate premiums for individuals and the public purse than non-STEM subjects.[1] STEM roles are also a significant part of the UK labour market: the Office for National Statistics (ONS) Labour Force Survey found that in July-September 2022, 2.8 million people were employed in professional scientific and technical occupations—with health included in the definition—representing approximately 8.5% of a total workforce of 32.7 million.[2] STEM workers are increasingly in demand: according to ONS data there were 125,000 job vacancies in professional scientific and technical activities between September and November 2022. Among the 18 industrial groupings used by the ONS this was the fourth highest figure and compared to 44,000 for the same quarter a decade earlier.[3]

3. Ensuring a continued flow of talent and commensurate opportunities in STEM roles is therefore of vital importance to the UK economy. However, it has long been clear that these opportunities are not equally distributed across society. 2014 research by the Royal Society found that women, people from certain ethnic backgrounds, people with disabilities, those from disadvantaged socio-economic backgrounds and those who declared themselves as being LGBTQ+ were under-represented in STEM education, into training and on to employment.[4] Our predecessors held similar inquiries in 2013,[5] 2014,[6] and 2016.[7]

4. One inquiry held by our predecessor Committee in 2013–14 examined women in scientific careers. It is sadly notable that many of their findings could apply today, for women or other under-represented groups we considered during this inquiry:

> It is astonishing that despite clear imperatives and multiple initiatives to improve diversity in STEM, women still remain under-represented at senior levels across every discipline […] Emphasis is often placed on inspiring young girls to choose science, which is commendable, but such efforts are wasted if women are subsequently disproportionately disadvantaged in scientific careers compared to men.[8]

1 London Economics, Assessing the economic returns to Level 4 and 5 STEM-based qualifications, 7 June 2017, p. 13
2 Office for National Statistics, Employment by industry (Labour Force Survey), 15 November 2022
3 Office for National Statistics, VACS02: Vacancies by industry, 13 December 2022
4 Royal Society, A picture of the UK scientific workforce, 7 February 2014, p. 7
5 Science and Technology Committee, Seventh Report of Session 2012–13, Educating tomorrow's engineers: the impact of Government reforms on 14–19 education, HC 665
6 Science and Technology Committee, Sixth Report of Session 2013–14, Women in scientific careers, HC 701
7 Science and Technology Committee, Second Report of Session 2016–17, Digital skills crisis, HC 270
8 Science and Technology Committee, Sixth Report of Session 2013–14, Women in Scientific Careers, HC 701, summary

5. The findings which follow are from contributions to our inquiry and offer a snapshot of the current under-representation of certain groups across STEM education, research and employment:

- Clare Viney from the Careers Research Advisory Centre told us that at the time of her appearance data showed there were no black male postdoctoral physics researchers in the UK. In chemistry, there were two;[9]
- Dr Yang Hu and Professor Monideepa Tarafdar pointed out that in 2018–2020 data only seven of the 27 STEM workforce Standard Occupation Classifications contained a larger proportion of women than men;[10] and
- EngineeringUK told us engineers from more advantaged socio-economic backgrounds were almost four times more likely to have progressed to intermediate, managerial or professional roles by the age of 30–39 than those from a less advantaged socio-economic background.[11]

6. In schools, the Education Endowment Foundation, a charity that works to improve educational attainment, has found that, on average, the equivalent of three more children in every reception-age classroom did not reach the expected level of development by the end of the 2021 school year compared with 2019.[12] Key stage 2 attainment statistics from 2022 suggest pupils from disadvantaged backgrounds were more affected by the disruption to education caused by the covid-19 pandemic.[13] During our joint inquiry examining lessons learned from the covid-19 pandemic, the then-Secretary of State for Health and Social Care, Matt Hancock MP, highlighted "… the wider societal benefit of schools being open, not least for education".[14] Professor Ray Pawson, Emeritus Professor of Social Research Methodology at the University of Leeds, told us isolation measures, such as school closures, increased educational disadvantage.[15] Ofsted, the Office for Standards in Education, Children's Services and Skills, has said in a report examining science education that "science has been particularly affected by covid-19 … restrictions deprived many pupils of the opportunity to take part in and learn from practical activities".[16]

7. Covid-19 has also changed the UK workforce, and analysis has suggested that "workers from an ethnic minority group, young and older workers, low paid workers, and disabled workers have been most negatively impacted economically by the coronavirus outbreak".[17] The first and last of these groups are covered in our Report.

9 Qq. 25–26, 29
10 Dr Yang Hu, Professor Monideepa Tarafdar, Jabir Alshehabi Al-Ani, Irina Rets, Shenggang Hu, Nicole Denier, Karen D. Hughes, Alla Konnikov and Lei Ding (DIV0095)
11 EngineeringUK (DIV0020)
12 Education Endowment Foundation, The impact of the Covid-19 pandemic on children's socio-emotional wellbeing and attainment during the Reception Year, 18 May 2022, p. 5
13 Gov.uk, Academic Year 2021–22 key stage 2 attainment, 15 December 2022
14 Oral evidence taken on 24 November 2020, HC (2019–21) 877, Q523 (Rt. Hon. Matt Hancock MP)
15 CLL0025
16 Ofsted, Finding the optimum: the science subject report, 2 February 2023
17 House of Commons Library, Coronavirus: Impact on the labour market, 20 April 2022, p. 26

Our inquiry

8. We launched our inquiry into diversity and inclusion in STEM on 22 November 2021, to explore the situation for women, people from certain ethnic backgrounds, people with disabilities, those from disadvantaged socio-economic backgrounds and those who declared themselves as being LGBTQ+ in STEM education, STEM research and STEM employment. We received and published over 100 written submissions and took oral evidence from 32 individuals, including representatives from under-represented groups, school leaders, the UK research ecosystem, the then Minister for Equalities, Kemi Badenoch MP, the Minister for Science, Research and Innovation, George Freeman MP, and the then Minister of State for School Standards, Robin Walker MP. We are grateful to everyone who contributed to our inquiry.

Aims of this Report

9. Although we received a great many contributions, by their nature Reports such as ours offer a snapshot of particular situations at particular moments; and we do not claim to have produced the last word, or an exhaustive research exercise, on diversity and inclusion in all STEM education, research or workplace settings. Our Report instead sets out the evidence we received regarding certain areas of STEM education in schools, research and employment, and ask what policies could be utilised to respond to under-representation where it exists. Specifically:

- In Chapter 2 we consider the nature and extent of under-representation in STEM settings, and what data is currently available.
- In Chapter 3 we focus on STEM education in schools, and the uptake and attainment trends among certain groups in STEM subject cohorts. We examine the importance of the curriculum, the teaching workforce, and what has been done by the Government. We also make recommendations for action that should be taken to address identified problems.
- Finally, in Chapter 4 we turn to the STEM workforce, primarily in research facilities but also in other employment settings.

2 The nature and extent of under-representation

10. STEM is not immune from wider societal trends and challenges, including the under-representation of certain groups in education, research and employment settings. Whilst the nature of this under-representation varies according to the group and setting, and the reasons it exists are complex, the overall picture is clear: under-representation is present in many STEM settings, from classrooms to research facilities, to boardrooms.

11. In this Chapter we outline what the evidence we received told us about the nature and extent of under-representation in STEM and what data is currently available to quantify it.

Why diversity matters

12. We heard that under-representation differed by setting and was dependent on several factors. UK Research and Innovation (UKRI) referred to a tendency to highlight individual examples of biases, rather than adopt a systemic approach across the whole of the research and innovation sector.[18] The importance of a systemic approach to solutions was also emphasised by Katherine Mathieson, then Chief Executive of the British Science Association. She argued that under-representation was systemic, present at all levels and society-wide and it was very challenging for single policies or interventions to make a significant difference.[19] She also said the limitations of good intentions were evident.[20]

13. The consequences of under-representation are clearly negative both for the individuals affected, society and the wider economy. Dr Claire Crawford of the Institute for Fiscal Studies said that in workplaces where under-representation exists, the outnumbered gender could experience more perceived or actual harassment;[21] whilst in their submission to our inquiry the Royal Society argued increasing the diversity of the STEM workforce should be a priority, as "any lack of diversity in the scientific workforce represents both an absence of talent that the UK could be benefitting from and a lack of opportunity for people in the UK".[22] In February 2023, the Government announced the establishment of a new Department for Science, Innovation and Technology, which has among its priority outcomes an intention to:

> […] put our public services—including the NHS and schools—at the forefront of innovation, championing new ways of working and the development of in-house STEM capability to improve outcomes for people.[23]

14. ***The Government should, in its response to this Report, tell us how it plans to monitor, evaluate and report on progress in delivering "in-house STEM capability" across public services, including the NHS and schools.***

18 UK Research and Innovation (DIV0084)
19 Q52
20 Q52
21 Q282
22 Royal Society (DIV0015)
23 GOV.UK, Making Government Deliver for the British People, 7 February 2023, p. 9

15. Dr Anna Zecharia, representing Equality, Diversity and Inclusion in Science and Health (EDIS), told us that diversity was a critical issue:

> These things play out in our institutions, processes and systems, and they inform who gets to succeed. Who you are has a bearing on how successful you are […] investing in STEM is good for productivity, creativity, problem solving and innovation, so why would we restrict ourselves to a tiny, tiny proportion of society? Just from a logical basis, you would not want to restrict your talent pool […] If we are only looking in a small section, we are doing ourselves a disservice.[24]

16. The importance of diversity amongst the research community was also acknowledged by UKRI Chief Executive, Professor Dame Ottoline Leyser, who told us:

> […] high-quality research and innovation needs diversity. You have to have people with different ideas and different backgrounds coming together to create the kind of environment where extraordinary things happen.[25]

17. The Department for Business, Energy and Industrial Strategy's submission to our inquiry also explained the importance of improving diversity:

> Diversity—of enquiry, perspective, opinion, and approach to the great scientific challenges of our times is key […] the R&D People and Culture Strategy also suggests that the R&D sector needs at least an additional 150,000 researchers and technicians by 2030 to sustain the UK's target of 2.4% R&D intensity. Diversifying and widening routes into R&D and inspiring people from all backgrounds to consider these careers are critical to addressing these challenges.[26]

18. We received a considerable amount of evidence that documented the distressing consequences of systemic discrimination for individuals. We are grateful to those who took the time to share their lived experiences, some for the first time, and many of whom contacted us despite the risks and difficulties associated with doing so.

An intersectional challenge

19. Intersectionality is defined as:

> The interconnected nature of social categorisations such as race, class, and gender, regarded as creating overlapping and interdependent systems of discrimination or disadvantage; a theoretical approach based on such a premise.[27]

In a Report that examined the embedding of equalities across the Government, the Women and Equalities Committee heard that an intersectional approach was important to examining inequalities:

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24 Qq. 54, 62
25 Oral evidence taken on 11 November 2020, HC (2019–21) 778, Q143 (Professor Dame Ottoline Leyser)
26 Department for Business, Energy, and Industrial Strategy (DIV0047)
27 Oxford English Dictionary, intersectionality, accessed 18 January 2023

> A range of witnesses expressed a balanced view, arguing that it was only possible to understand and tackle the root causes of inequalities by considering the interaction between the whole range of factors, including socio-economic and geographic and those related to one or more protected characteristics and the 'intersections' between them.[28]

Research undertaken by the Equality Challenge Unit (now Advance HE),[29] found that an intersectional approach to equality and diversity offered several benefits:

> […] it provides an understanding of the issues that is closer to the lived experiences of the equality groups that you are interested in, thus allowing you to develop effective strategies to address them. It therefore aids in the development of appropriate equality objectives and equality outcomes […] conducting intersectional research is not necessarily complicated, provided that you formulate adequate research questions, choose your methods carefully and interpret your results from an intersectional perspective.[30]

20. Contributors to our inquiry, including the Mathematical, Physical and Life Sciences Division of the University of Oxford, stressed that the individual groups examined in our Report should not be viewed in isolation, that the challenge of under-representation was often intersectional and different characteristics combined to construct barriers to progress:

> […] an able-bodied white woman from a lower socio-economic background will likely have a different set of challenges from a disabled woman of colour from an economically privileged background, while still sharing some experiences navigating a male-dominated sector.[31]

The Royal Society of Chemistry told us the challenge was particularly acute for individuals belonging to multiple under-represented groups.[32]

21. In their submission to our inquiry BEIS said quantifying the extent of intersectional challenges in relation to STEM roles was challenging,[33] but were among those to highlight the valuable contribution of the All-Party Parliamentary Group on Diversity and Inclusion in STEM, which attempted to take an intersectional approach—subject to limitations in the available data, discussed later in this Chapter—in its reports on inequity in STEM education and the STEM workforce.[34, 35]

28 Women and Equalities Committee, First Report of Session 2021–22, Levelling Up and equality: a new framework for change, HC 702, para 23
29 Advance HE, About us, accessed 18 January 2023
30 Equality Challenge Unit, Intersectional approaches to equality research and data, 18 April 2017, p. 2
31 Mathematical, Physical and Life Sciences Division, University of Oxford (DIV0063)
32 Royal Society of Chemistry (DIV0032)
33 Department for Business, Energy and Industrial Strategy (DIV0047)
34 All-Party Parliamentary Group on Diversity and Inclusion in STEM, Inquiry on Equity in STEM Education: final report, 23 June 2020
35 All-Party Parliamentary Group on Diversity and Inclusion in STEM, Inquiry into Equity in the STEM workforce: final report, 20 July 2021

Data limitations—STEM research and workforce roles

22. In a 2018 report, the National Audit Office found that the then Government did not "gather robust intelligence on the STEM skills issues it has already started to address"[36] and that "current estimates of the STEM skills problem vary widely, and typically focus only on individual sections of the workforce".[37]

23. Cogent Skills, a not-for-profit organisation which aims to raise skill levels in the life sciences, industrial sciences and nuclear sectors, said that while important for employers, collecting comprehensive diversity data was a challenge:

> […] collecting and reporting on diversity data is a known challenge, often leading to complex processes which can be resource intensive. The issue of disclosure (or collection) of certain data can be sensitive, with no legal obligation for employees to disclose certain diversity characteristics, resulting in low return rates and poor quality data.[38]

We also heard that the approach to data collection and subsequent reporting was fragmented. The Institute of Physics said:

> There is currently no UK-wide, sector-wide or enforceable method for collecting data on the demographics of those working in STEM. The lack of comprehensive quantitative data on the picture of UK STEM makes change in the sector difficult to track and benchmark, meaning diversity improvement and the effectiveness of interventions cannot be measured.[39]

24. The Careers Research and Advisory Centre (CRAC) told us that because of limited data, the extent of the challenge was not fully understood.[40] Clare Viney, CRAC Chief Executive, also described how limited data affected evaluation of efforts to increase diversity and inclusion:

> It makes measuring success and impact difficult because you are not always comparing like-for-like situations. We are investing a lot of money—over £1 billion—in STEM outreach, but we cannot always say how effective that has been. There are a lot of interventions that are extremely well meaning and, obviously, impactful in a small way, but how do we look at it systemically?[41]

Professor Jeremy Sanders, Chair of the Royal Society Diversity Committee, said it had examined various under-represented groups and underlined the importance of data and a consistent definition of STEM roles.[42]

36 National Audit Office, Delivering STEM (science, technology, engineering and mathematics) skills for the economy, 17 January 2018, p. 6
37 National Audit Office, Delivering STEM (science, technology, engineering and mathematics) skills for the economy, 17 January 2018, p. 7
38 Cogent Skills (DIV0052)
39 Institute of Physics (DIV0033)
40 Careers Research & Advisory Centre and Vitae (DIV0050)
41 Q21
42 Qq. 1, 33

25. Demographic data for staff and students in higher education is monitored by the Higher Education Statistics Agency (HESA) and Advance HE.[43] Universities UK pointed out that both were reliant on individuals being willing to disclose:

> The data is based on self-disclosure and so underestimates where staff (and students) are not willing to disclose […] While data is an important tool in understanding the nature and scale of inequity, it is important that individuals should not feel pressured into disclosing more than they are comfortable doing.[44]

26. The Government itself accepted that the quality of diversity data varied,[45] but told us that a new BEIS survey would improve the quality of data available:

> […] a new UK-wide R&I workforce survey […] will improve the quality of diversity data (sex, gender, disability, ethnicity) of R&I [research and innovation] occupations including many STEM occupations, and will allow Labour Force Survey (LFS) data on personal characteristics to be used to estimate R&I workforce diversity, as the new BEIS survey will find out how much R&I is done in each of the Standard Occupations recorded in LFS.[46]

However, Clare Viney, CRAC Chief Executive, warned that the survey's wide net could potentially create further complexity, and that its findings would need to be drawn on across Government to maximise its impact:

> […] it is not connecting datasets. It is a survey […] there is the issue of the definition of STEM and R&D […] Locking some of these things down and making sure that you are measuring like for like and not looking at bananas and kumquats is really important […] We could try to make the survey more useful by […] looking at ethnicity culture. There will be some culture questions in the survey. Benchmarking is really useful. That investment is great. Can we do more? Can it be more sustained? Yes.[47]

George Freeman MP, Minister for Science, Research and Innovation, told us the survey would provide accountability and transparency, including monitoring progress being made "on some of the tangible outcomes".[48]

Data limitations—STEM education

27. The data available in relation to STEM education differs from that for the STEM workforce. Many of the issues we discuss in Chapter 3 of this Report, such as uptake and attainment in STEM subjects by children from under-represented groups, are informed by datasets compiled by the Department for Education and Ofsted.[49,50] These can be used to analyse STEM subject uptake and attainment by gender, ethnic background, and indicators of socio-economic background, such as eligibility for free school meals (FSM).

43 The Inclusion Group for Equity in Research in STEMM (DIV0071)
44 Universities UK (DIV0023)
45 Department for Business, Energy and Industrial Strategy (DIV0047)
46 Department for Business, Energy and Industrial Strategy (DIV0047)
47 Q20
48 Q450
49 Department for Education, Explore education statistics, accessed 18 January 2023
50 Gov.uk, Statistics at Ofsted, accessed 18 January 2023

28. Data on pupils with special educational needs is also compiled by the Department for Education,[51] although the British Science Association told us that gender and to a lesser extent ethnicity have generally been the focus of data compiled by the Government and the STEM sector.[52]

29. With multiple bodies involved in the compilation and assessment of diversity data, some contributions to our inquiry highlighted the potential for confusion and inconsistency. The Protect Pure Maths campaign said limited availability of national and subject specific data should be addressed and suggested the creation of a central dashboard to monitor progress.[53]

30. Dr Jake Anders, Deputy Director at the UCL Centre for Education Policy and Equalising Opportunities (CEPEO), also told us that a balance between compiling data before acting on the findings later, and moving ahead with interventions, was required:

> There is a balance between saying every so often, "This is a big problem. Why is nothing happening about it?", and saying, "We have to fix it in two years." We need to make sure that we see incremental progress and have the data available to track that, which is a big challenge.[54]

31. Mathematics Education for Social Mobility and Excellence told us that a limited ability to connect datasets affected the extent to which progression by individuals from underrepresented groups could be monitored through school and into higher education.[55] Clare Viney, CRAC, explained why this would be more beneficial than surveys:

> We have a good example, which is not completely perfect, in LEO, the Longitudinal Education Outcomes Dataset. We have joined the tax records—HMRC data—with our student data, so we are able to see progression from undergraduate level. Surveys are great and give you a feel for or an understanding of what is going on, but joining datasets is really the way to understand what is going on longer term.[56]

32. **The benefits of raising levels of diversity and inclusion in STEM education, research settings and workplaces were highlighted by many contributors to our inquiry. The Government, UKRI, other research funders, industry and the education sector have led and participated in many worthy inquiries, reports and initiatives. Yet progress has been limited at best. The status quo must not be accepted by those with the ability to drive change. It is not simply a legacy problem that will fade as society becomes more diverse. Action must be taken that truly moves the dial.** ***The Government should make improving diversity and inclusion in STEM—and indeed in all aspects of society—a central part of its day-to-day activities and future agenda. It's not just good for business, it is fundamentally about being fair, and doing the right thing. The education and research sectors must follow the Government's lead and take a systemic approach to the challenge, making the STEM ecosystem in the UK a beacon of good practice when it comes to addressing under-representation.***

51 Department for Education, Special educational needs in England, accessed 18 January 2023
52 British Science Association (DIV0044)
53 Protect Pure Maths (DIV0086)
54 Q86
55 Mathematics Education for Social Mobility and Excellence (DIV0039)
56 Q16

33. **Improved data collection and the application of lessons from it are key to addressing under-representation. We welcome the biannual Research and Innovation workforce survey being led by BEIS, and the Government's recognition of the need to better capture the diversity challenge on the basis of characteristics other than gender—such as ethnicity, disability, sexuality, and socio-economic background. A survey can, however, only ever provide a snapshot, whilst concerted, targeted action would be better informed by a longitudinal study.** ***The Government should set out how it plans to make the Research and Innovation workforce survey meaningfully useful across different departments, non-departmental bodies and the wider STEM sector. The forthcoming results must be accompanied by an action plan, and the survey should have the ability to undertake analysis by STEM occupation built in.***

3 STEM education in schools

34. Educational settings are not immune from wider societal challenges and the consequences of under-representation, they are significantly affected by them. Children's experiences in the classroom shape their life choices and outcomes, which in turn shape the composition and diversity of the workforce. The Social Mobility Commission has identified educational opportunities and quality of schooling as one of four drivers of social mobility.[57]

35. In this Chapter, we will refer to subjects generally accepted as sitting under the STEM umbrella, such as biology, chemistry, computer science, mathematics, and physics. We will examine differences in post-16 subject take-up, and how these affect the UK STEM workforce. We will also outline the characteristics, causes and consequences of underrepresentation in STEM education settings, examine the relationship between these and wider challenges faced by the sector, and assess what has been done to address them. This Chapter is primarily concerned with the situation in schools, although we also acknowledge the important role of Further Education Colleges.

Diversity and inclusion in the STEM curriculum

36. The national curriculum is defined by the Government as:

> […] a set of subjects and standards used by primary and secondary schools so children learn the same things. It covers what subjects are taught and the standards children should reach […] academies and private schools do not have to follow the national curriculum. Academies must teach a broad and balanced curriculum including English, maths and science.[58]

The curriculum is divided into four key stages plus early years. The current STEM curriculum, which applies to all local authority-maintained schools in England,[59] was introduced in September 2016 (maths for all year groups and science up to and including year 10),[60] and September 2017 (science for year 11).[61]

37. Contributions to our inquiry highlighted the importance of the curriculum in shaping pupil perceptions and subject decisions and argued that it constrained efforts to make STEM more diverse and inclusive. Teach First, an education charity, told us about research they undertook, which found:

> […] not a single woman's name explicitly features in the national curriculum for GCSE science. And in a sample analysis of the GCSE double science specifications from three of the major exam boards, we found that only two female scientists were explicitly named. In contrast, over 40 male scientists were mentioned, or had concepts or materials named after them.[62]

57 Social Mobility Commission, State of the Nation 2022: a fresh approach to social mobility, p. 103
58 Gov.uk, The National Curriculum, accessed 18 January 2023
59 Gov.uk, Collections: The National Curriculum, accessed 18 January 2023
60 Gov.uk, National curriculum in England: mathematics programmes of study, accessed 18 January 2023
61 Gov.uk, National curriculum in England: science programmes of study, accessed 18 January 2023
62 Teach First (DIV0037)

However, Sam Freedman, a former Department for Education adviser and Senior Fellow at the Institute for Government, pointed out:

> […] the national curriculum is much shorter than most people think it is. There are very few people named anywhere in it in any subject. It sounds worse than it probably is to say there are no explicitly mentioned female scientists because there are very few women mentioned at all in any subject. There were not particularly conversations around it, certainly at the ministerial level, when the national curriculum was being designed.[63]

Russell Hobby, Chief Executive of Teach First, said greater diversity in the curriculum could be delivered at low cost, without extensive reform:

> […] we could create resources that, for example, allowed people to see themselves in scientific discoveries, in the stories of mathematics and engineering, and so on. There are schools working on this already, so we could take those resources and make them more widely available […] it does not need major change to the specifications. The same is true for what we put in the exam spec.[64]

Professor Dame Athene Donald of the University of Cambridge argued that the curriculum should form a key part of addressing under-representation from the earliest years:

> Interventions need to start early in life; waiting until decisions are taken around the time of GCSEs or equivalent is too late. Teachers at all stages need to be trained to be sensitive to the impact of unconscious bias and how it affects their behaviour in the classroom; examples of non-white, non-male scientists should be made accessible to all children from the earliest years.[65]

When asked about the curriculum's diversity, the then Minister for School Standards, Robin Walker MP, said it prioritised scientific knowledge over personalities:

> There are very few male scientists represented in the national curriculum in England. When I go into schools, I see a lot of displays and information about people like Marie Curie and Ada Lovelace, so there is very good teaching going on in our schools about female role models in the sciences and computing […] it is important in other areas—when we talk about careers and the reasons for going into STEM—that we use some of those examples, and schools do that very effectively.[66]

38. **All children should be able to see themselves in what they learn from an early age. *The national curriculum and exam subject specifications should be kept under review and updated where it is appropriate to the context to include more diverse examples, such as female scientists.***

63 Q158
64 Qq126-27
65 Professor Dame Athene Donald (DIV0008)
66 Q373

Role models

39. The ability of teachers who deliver the curriculum, as well as other role models, to influence pupils' subject interests and career decisions, was also examined during our inquiry. Claudenia Williams told us how the support she received at a young age led her to her current role as assistant principal and science teacher at the Kingsley Academy in Hounslow:

> Both my dad and my mum had come from Jamaica, and my mum had learned to read at the same time as me, at primary school […] I do not think I would be here, in a senior role in a school leading change, had it not been for the fact that, when I was 16, somebody opened that door for me, and showed me that university was a real option […] making it real, for somebody like me, coming from my background, meant that I pursued the idea. It allowed me to push on despite the barriers that I faced because of my protected characteristics.[67]

40. We also heard that children who were able to see themselves as scientists or engineers were more likely to pursue the required subjects. Katharine Birbalsingh—then-Chair of the Social Mobility Commission and headmistress at Michaela Community School in Wembley—agreed there was a link between under-representation of certain groups in STEM roles and which pupils chose to pursue an interest in STEM:

> I totally believe in role models. We have people coming in every couple of weeks, if not more often, from different backgrounds and professions to come and speak to the children and say, for instance, "This is what I do, and here are some things to think about." We then make sure that all the children are signing up. You have 100 or so kids in each of these talks listening to what they are saying.[68]

Professor Dame Athene Donald told us teachers, peers and other role models could unconsciously reinforce societal stereotypes, particularly in co-educational schools,[69] and drew our attention to research examining five decades of 'Draw-a-Scientist' studies in the United States, which suggested that although some progress has been made, traditional gender stereotypes remained:

> Children's depictions of scientists therefore have become more gender diverse over time, but children still associate science with men as they grow older. These results may reflect that children observe more male than female scientists in their environments, even though women's representation in science has increased […][70]

41. The then Minister for Equalities, Kemi Badenoch MP, told us that role models should be drawn from everyday life as well as wider society, and that people shouldn't need to see themselves in others to be inspired by them:

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67 Q111
68 Q216
69 Q267
70 Society for Research in Child Development, The Development of Children's Gender-Science Stereotypes: A Meta-analysis of 5 Decades of U.S. Draw-A-Scientist Studies, 20 March 2018, p.1

> […] it is more about role models within your immediate community […] There is a structural challenge there because we cannot replace who is in someone's family or community. Having some of those visible, high-level role models is important, but encouraging people to be able to see themselves in someone who does not necessarily look like them is also important.[71]

42. Contributors to our inquiry highlighted educational outreach activity by individual institutions and employers as helping influence career decisions, as well as the work being done by organisations such as Speakers for Schools, which delivers in-school talks and work experience placements as well as other forms of outreach activity.[72] However, Professor Dame Athene Donald cautioned that outreach activity varied in its effectiveness, noting that:

> […] you are often reaching the people who already have that kind of cultural capital. It is very important to reach out to people in disadvantaged areas, and that is always harder […] We need diverse people going in. People from industry can really do good things by going in and talking about their day job. An academic might not be the right person at all. We should think about who gets involved with those programmes and try to make it easier to do that. That also applies to work experience.[73]

43. Other initiatives, such as the STEM Ambassador Programme managed by STEM Learning, undertake similar work. STEM Learning outlined the impact of its programme:

> These passionate, committed volunteers come from the widest range of backgrounds imaginable. They are relatable—the majority (57%) are under 35. Their visible diversity challenges stereotypes—nearly half (45%) are female and 15% are from UK minority ethnic backgrounds […] working for over 7,000 different employers with around 1,400 working in technician or other technical roles.[74]

Robin Walker MP, the then Minister for School Standards, told us that the Government was aware of the need to increase pupil's access to diverse role models but argued that existing initiatives, such as careers hubs, were already making a difference.[75] The careers hubs system was launched by the Careers & Enterprise Company in 2018 and expanded in 2019.[76] It links schools and colleges with employers, further education institutions and individual professions to deliver careers support and guidance. Paul Kett, Director General of the Skills Group at the Department for Education, said the model was expanding and included STEM-specific content and guidance for schools.[77]

44. **The careers advice and support pupils receive from the earliest years must promote diverse and inclusive role models. Just as it is desirable for children to see themselves in what they learn, they should also see themselves in who they aspire to emulate.** ***The***

71 Q425
72 Speakers for Schools, About, accessed 18 January 2023
73 Q285
74 STEM Learning (DIV0076)
75 Q398
76 Department for Education, Education Secretary announces £2.5m boost to Careers Hubs in 20 areas, accessed 18 January 2023
77 Q399

Government should consider how best to support schools and existing programmes, such as STEM Ambassadors, Speakers for Schools, and the Careers and Enterprise Company, to ensure children access a diverse range of role models from research or industry. Careers advice guidance and support should also be regularly reviewed to ensure they reflect a full range of diverse examples.

Pupil choices in STEM subjects

45. As set out in Chapter 2, comparisons between and within the groups under-represented in STEM education, research, and employment settings are complex, and subject to limitations in the data available. However, there are clear patterns in the available data regarding uptake and attainment up to the age of 18 years old.

Double and triple science

46. At the age of 13–14 years old most pupils choose the subjects they wish to continue with at key stage 4, during which they pursue national qualifications—generally GCSEs. Maths and science are core GCSE subjects, and pupils can choose either combined—widely and in this Report referred to as double science—where they study elements of biology, chemistry and physics but are awarded two GCSEs; or triple science, where they study and are awarded individual GCSEs for each of the three.[78]

47. We heard that triple science is widely regarded as more advantageous in accessing further scientific studies beyond the age of 16. Dr Rebecca Montacute, Senior Research and Policy Manager at the Sutton Trust, told us schools from more deprived areas were less likely to offer triple science, while pupils at schools in less deprived areas, such as London and the south-east, were more likely to have this option available to them.[79]

48. Professor Louise Archer of the University College London Institute of Education and member of the ASPIRES research project, told us that for students from certain groups—particularly those from less advantaged backgrounds—not having the chance to pursue triple science, was a particular challenge. The ASPIRES project found most students were not given a choice over which route to take.[80]

49. Teach First examined access to triple science through the lens of ethnic background, and cited findings from the Hamilton Commission launched by Sir Lewis Hamilton to examine barriers to greater diversity and inclusion in motorsport. Teach First also outlined the consequences for pupils who found themselves unable to pursue triple science:

> […] fewer Black Caribbean students studied the Triple Science route than any other ethnic background […] Top set students are more likely to be offered triple science pathways compared with middle and bottom sets, but evidence shows that Black students are less likely to be placed in these top sets in schools […] entry to Triple Science matters because Triple Science

78 Department for Education, Combined Science GCSE subject content, 3 July 2015
79 Q79
80 UCL Institute of Education, ASPIRES 2 Triple Science Policy Briefing, accessed 18 January 2023

> is often required by schools and colleges for progression to A-levels in the sciences—and then, ultimately, for access to further or higher education, and a career in STEM.[81]

The Royal Astronomical Society were also among those to note that access to triple science was an important factor in pupils being able to pursue science studies at A-level,[82] and cited a striking ASPIRES project finding:

> The close alignment of Triple Science with the STEM pipeline discourages Double Science students from considering post-compulsory science. Moreover, despite official advice, many schools do not consider Double Science as providing ample preparation for science A-levels.[83]

Dr Jasper Green, an Inspector and subject lead for science at the Ofsted Curriculum Unit, explained that the current inspection framework provided clear guidance about pupil choices, and that schools could delay the decision until year 10 or year 11:

> It is up to schools to choose when they make those decisions about triple science and combined science, but it is the rationale behind that choice that is important. Have leaders thought carefully about, for example, whether they are monitoring which pupils are not taking triple science? Are they aware of that? Are they recognising the challenges of selecting triple science, for example, at the end of year 8 or even year 9?[84]

Uptake and attainment at GCSE and A-level

50. We will now examine uptake and attainment in STEM subjects among different groups at GCSE and A-level. When doing so it is important to consider the effects of the cancellation of exams in 2020 and 2021 owing to the covid-19 pandemic. Although exams went ahead in 2022, the impact of the pandemic remained visible in the provision of advance information, more topic choices, and equation sheets.[85] This reflected an intention set out by Ofqual, the exams regulator, to make 2022 a 'mid-point' between 2019 and 2021 in terms of results.[86]

Gender

51. The data below refers to all schools[87] in England in 2018/19, with percentages rounded to the nearest number.

81 Teach First (DIV0037)
82 Royal Astronomical Society (DIV0035)
83 UCL Institute of Education, ASPIRES 2 Triple Science Policy Briefing, accessed 18 January 2023
84 Q257
85 House of Commons Library, Coronavirus: GCSEs, A Levels and equivalents in 2022, 6 June 2022, p. 5-6
86 Gov.uk, Ofqual's approach to grading exams and assessments in summer 2022 and autumn 2021, accessed 18 January 2023
87 Gov.uk, Key stage 4 performance 2019 (revised) subject data, 6 February 2020

Table 1: Uptake and attainment in STEM subjects by gender at GCSE and A-level, 2018–19

Subject	Total female entries, GCSE	Total male entries, GCSE	Female entries, GCSE (%)	Male entries, GCSE (%)	9–4 GCSE, female (%)	9–4 GCSE, male (%)	Total female entries, A-level	Total male entries, A-level	Female entries, A-level (%)	Male entries, A-level (%)	A*–C A-level, female (%)	A*–C A-level, male (%)
Maths	272,761	281,532	49	51	72	71	30,402	47,869	39	61	76	76
Physics	77,225	79,747	49	51	91	91	7,636	26,493	23	77	71	70
Biology	79,620	81,750	49	51	92	89	37,647	22,075	63	37	68	65
Chemistry	77,722	80,273	49	51	91	90	27,463	23,708	54	46	72	72
Double Science GCSE	193,111	195,284	49	51	58	53	N/A	N/A	N/A	N/A	N/A	N/A
Computing	16,810	60,759	22	78	66	62	1,322	8,713	13	87	63	63

Source: Gov.uk, Key stage 4 performance 2019 (revised) subject data, 6 February 2020, Gov.uk, A level and other 16 to 18 results: 2018 to 2019 (revised), 23 January 2020

52. It is striking that at A-level in three subjects—maths, physics and computing—there is a significant imbalance between boys and girls in uptake, but not attainment. There was no consensus in the evidence our inquiry received as to the causes of this, but two broad schools of thought emerged from witnesses:

- The view that the imbalance reflected longstanding and wider perceptions and prejudices in society as to which subjects girls 'should' study, coupled with a discouraging environment for girls in maths, physics and computing;

- The view that the imbalance reflected—in some schools at least—a mature choice by girls considering their future study choices (medicine, for example) and that, counter-intuitively, the imbalance may be principally caused by boys' over-representation in a smaller range of subjects, reflecting lower confidence among boys in studying the arts and humanities.

In practice, the explanation may be a combination of the two broad analyses.

53. Dr Claire Crawford of the Institute for Fiscal Studies described physics and maths as established outliers, although she also pointed out that this remained relative:

> Maths and physics are the two most popular subjects to take among boys. Even for girls, maths is the third most popular subject to take at A-level. There are still significant numbers of girls taking maths in particular, but still relatively fewer than boys, for whom it is a very popular subject. Physics is much less popular for girls, but still more popular among them than, say, English is among boys.[88]

54. The UCL Centre for Education Policy and Equalising Opportunities (CEPEO) said the delivery of the maths and physics curriculum, and the content itself, could be a factor in determining uptake:

> As part of a research project we undertook on why girls were less likely to study maths and physics, we surveyed girls predicted to do well in GCSE maths or physics early in Year 11 […] they pointed to there being a content-heavy curriculum which meant teachers had to focus on exam content in a fairly dry and repetitive manner and weren't able to go into detail on topics of interest to the students. Most girls also perceived the quality of physics teaching in particular to be low—perhaps because the majority of students are taught physics by a non-specialist (because of a shortage of physics teachers).[89]

We will return to the workforce-related issues raised by CEPEO later in this Chapter.

55. When asked to account for the fact that 84% of the A-level physics cohort were male at her co-educational Michaela Community School in Wembley, Katharine Birbalsingh said it was due to preference:

> From my own knowledge of these things, physics is not something that girls tend to fancy. They don't want to do it. They don't like it […] My explanation for the children we have here is just that they don't want it.

88 Q258
89 UCL Centre for Education Policy and Equalising Opportunities (DIV0112)

> They would prefer to do biology and chemistry […] There is a lot of hard maths in there that I think that they would rather not do. That is not to say that there isn't hard stuff to do in biology and chemistry—there is—but it is not mathematics.[90]

This proved to be a controversial observation, and was contested by other contributors to our inquiry, including Professor Rachel Oliver FREng, Dr Jess Wade BEM, Dr Izzy Jayasinghe, FRMS, Angela Saini, and Professor Christina Pagel.[91]

56. Professor Dame Athene Donald pointed to another possible explanation for the choices made by female and male students, namely differing rates of maturity:

> […] there is the argument that girls mature earlier and that they are more fluent. I don't know whether that is really borne out—it is not my area—but they seem to think they have more choices and therefore if they are being discouraged, passively or actively, from doing STEM subjects, they may stay in the arts and the boys may feel, "Well, I can do my maths. That's fine. I'll stick with that." We need to try to make all our schools as inclusive as possible, so that neither gender feels pushed in either direction.[92]

57. STEM Learning pointed out that while 12.5% of females who took GCSE biology continued it at A-level just 7.2% of males did so.[93] CEPEO said biology was the second most popular A-level subject among females, and the gap in uptake between them and males had become more pronounced:

> […] girls are around 20% more likely than boys to take A-levels at all, and are also more likely to take some STEM subjects. For example, girls were already nearly 30% more likely to take A-level biology than boys in 2010, and have extended their advantage since then, to 70% more likely in 2019.[94]

58. For computing, the subject with the starkest disparities, Dr Green from Ofsted told us that in 2021 the disparity was 85%:15%, although he pointed out that the percentage of females who chose it at A-level had grown by 6% since 2017.[95] This is perhaps a result of the £84 million spent on improving teaching at GCSE and A-level referred to by the Government in its submission to our inquiry,[96] although the picture at GCSE in terms of uptake remains less positive.[97]

59. Professor Dame Athene Donald recalled a time when computing was perceived to be a 'female' subject but said this was no longer the case,[98] whilst Dr Green said that between 2017–2021 the number of female students choosing GCSE Computer Science had

90 Qq. 210–212
91 Professor Rachel Oliver FREng, Dr Jess Wade BEM, Dr Izzy Jayasinghe, FRMS, Angela Saini, and Professor Christina Pagel (DIV0106)
92 Q290
93 STEM Learning (DIV0076)
94 UCL Centre for Education Policy and Equalising Opportunities (DIV0112)
95 Qq. 252, 254
96 Department for Business, Energy and Industrial Strategy (DIV0047)
97 Computer Weekly, Number of girls taking GCSE computing drops in 2021, accessed 18 January 2023
98 Professor Dame Athene Donald (DIV0008)

increased by 6%.[99] It is notable that females who did choose computing achieved better or similar results than their male counterparts at both GCSE (66%–62% achieved 9–4) and A-level (63.1%–63.2% achieved A*–C) in 2019.[100, 101]

60. For comparison, the table below shows the uptake and attainment by boys and girls at A-level for Art and Design, English literature and language, Government and Politics, and History, in the 2018/19 academic year.

Table 2: Uptake and attainment in arts and humanities subjects by gender at A-level, 2018–19

Subject	Total female entries, A-level	Total male entries, A-level	Female entries, A-level (%)	Male entries, A-level (%)	A*–C A-level, female (%)	A*–C A-level, male (%)
Art and Design	24,338	8,566	74%	26%	86.5%	79.2
English literature and language	41,554	13,333	76%	24%	80.4%	76.8%
Government and Politics	8,450	8,998	48%	52%	78.8%	81.4%
History	25,790	19,970	56%	44%	81.5%	79.9%

Source: https://www.gov.uk/government/statistics/a-level-and-other-16-to-18-results-2018-to-2019-revised

61. Kemi Badenoch MP, then Minister for Equalities, highlighted the wider context as important to the discussions regarding uptake and attainment:

> Is the issue of girls not studying physics in the same number as boys a game changer in terms of outcomes? Is it a game changer in terms of social mobility for that specific subject? I do not know that is the case, so it would not be where I would start in government intervention.[102]

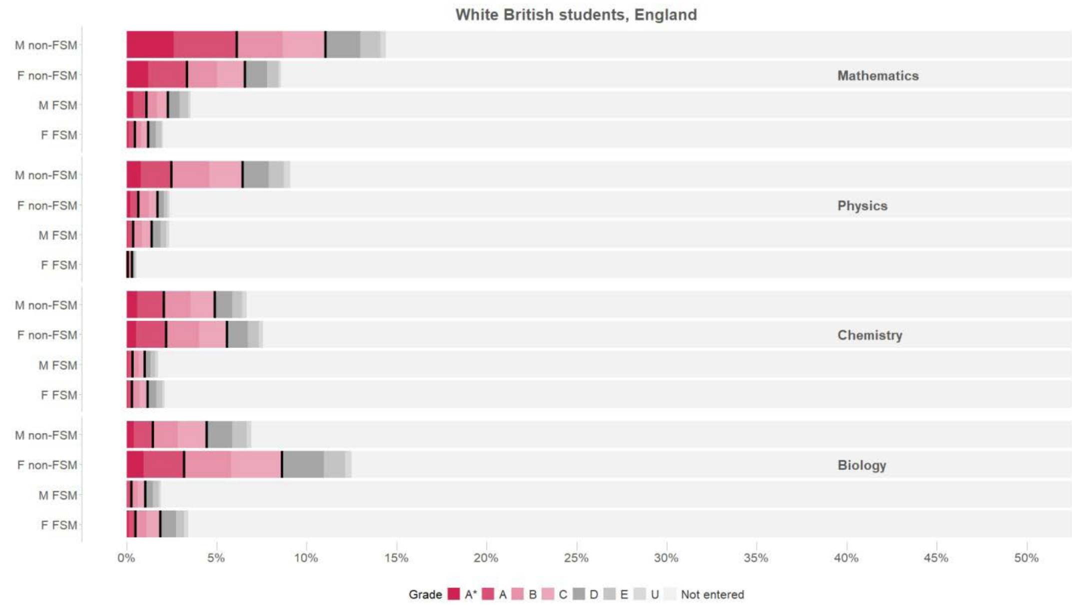
Ethnic background

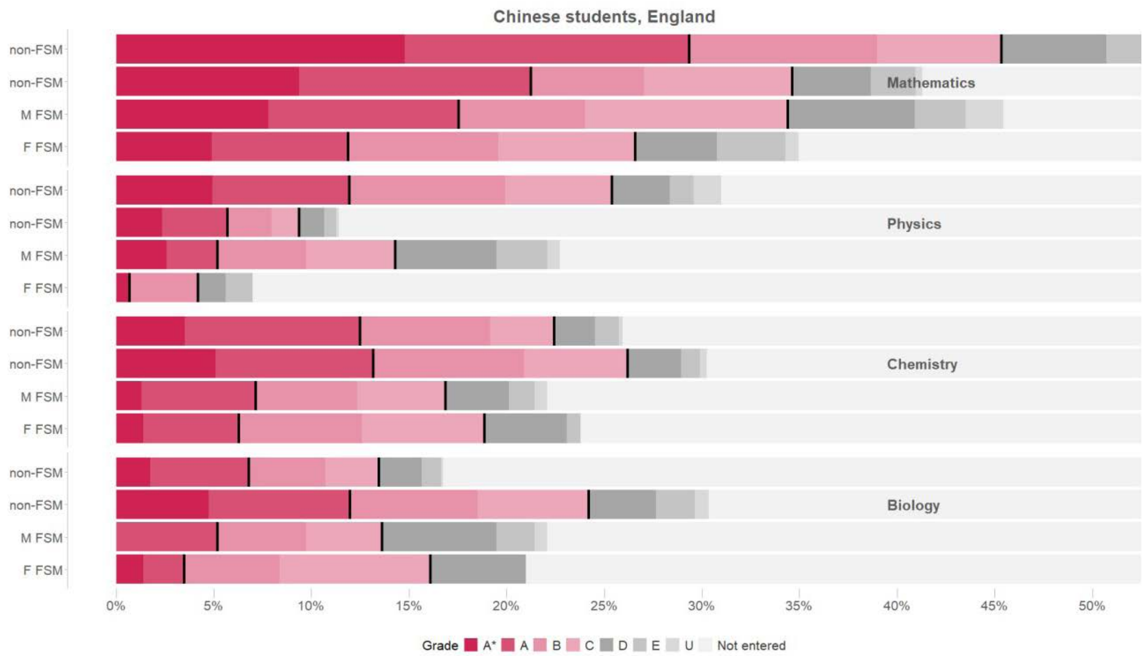
62. There are significant variations in attainment data when examined based on ethnic background. STEM Learning told us that whilst pupils from a Chinese background are among the highest performers in GCSE maths, regardless of gender or socio-economic background, those from a Black Caribbean background are the lowest performers.[103] King's Maths School said this was seriously limiting efforts to improve diversity in STEM, arguing Black Caribbean pupils:

> […] attain lower than their peers at all levels and this is the primary barrier to them accessing competitive degrees in the mathematical sciences and continuing on to STEM based careers. In order to diversify the mathematical sciences, we must focus on improving the attainment for these groups.[104]

99 Q254
100 Gov.uk, Key stage 4 performance 2019 (revised) subject data, 6 February 2020
101 Gov.uk, Key stage 4 performance 2019 (revised) subject data, 6 February 2020
102 Q432
103 STEM Learning (DIV0076)
104 King's Maths School (DIV0078)

63. As is the case with maths, the data on uptake and attainment in physics when viewed through the lens of ethnic background varies considerably. STEM Learning said pupils at schools in England with Chinese and Asian Indian backgrounds were among the highest performers at physics GCSE, with their peers from Black Caribbean, Black African, and White British among the lowest. Trends that emerge at GCSE become more evident at A-level, where more pupils with Chinese backgrounds pursue physics than their White British peers; and outperform them.[105] The two charts below, from STEM Learning's submission to our inquiry, show attainment in STEM A-levels by White British and Chinese female and male students (where FSM is short for Free School Meal eligibility).[106]





105 STEM Learning (DIV0076)
106 STEM Learning (DIV0076)

64. The intersection of ethnicity with other characteristics, such as socio-economic background, can affect uptake and attainment. For example, a correlation can be observed between FSM eligibility and reduced uptake and attainment amongst even high-performing pupils at both GCSE and A-level—such as those from Asian Indian or Chinese backgrounds—compared with their non-FSM eligible peers. [107] However, some disparities are visible regardless of how the data are analysed—as the Hamilton Commission report illustrated:

> Physics GCSE entry numbers for Black Caribbean and Mixed White and Black Caribbean students are lowest among all ethnic groups regardless of gender or free school meal status.[108]

65. In chemistry, pupils with Chinese and Asian Indian backgrounds outperform all others in both uptake and attainment at GCSE and A-level, particularly pupils from White British and Black Caribbean backgrounds.[109] In computing, it is notable that whilst students from a Black Caribbean background remain among the lower performers in terms of uptake and attainment, the data does suggest a greater interest compared with other STEM subjects, at both GCSE and A-level.[110]

Socioeconomic background

66. The Protect Pure Maths campaign told us of clear trends in the data on socio-economic background, the effects of which were observed at later stages of education:

> Just 25% of disadvantaged pupils achieve a good pass in GCSE maths […] In 2019, 7% of all students taking A-level Further Mathematics were classified as disadvantaged, compared with 12% of all A-level students and c.30% of the state school population as a whole. The majority of those going on to study a degree in mathematical sciences have taken A-level Further Maths, so this is a key indicator of how many disadvantaged students will go on to study mathematical sciences at university.[111]

Mathematics Education for Social Mobility and Excellence, a charity, argued that the trend could be observed even at the earliest stages of education, with 16% of disadvantaged pupils reaching the expected key stage 2 standard in maths in 2019, compared to 32% of all pupils.[112] Uptake and attainment in physics also correlates closely with socio-economic background,[113] and the same applies to chemistry.[114]

107 STEM Learning (DIV0076)
108 The Hamilton Commission, Accelerating Change: Improving Representation of Black People in UK Motorsport, 13 July 2021, p. 92
109 STEM Learning, Science Education in England: Ethnicity, Gender and Disadvantage at GCSE and A level (Charts), February 2022, pp. 5–6, 19–20
110 STEM Learning, Science Education in England: Ethnicity, Gender and Disadvantage at GCSE and A level (Charts), February 2022, pp. 15–16, 25–26
111 Protect Pure Maths (DIV0086)
112 Mathematics Education for Social Mobility and Excellence (DIV0039)
113 STEM Learning, Science Education in England: Ethnicity, Gender and Disadvantage at GCSE and A level (Charts), February 2022, pp. 5-6, 19-20
114 STEM Learning, Science Education in England: Ethnicity, Gender and Disadvantage at GCSE and A level (Charts), February 2022, pp. 15-16, 25-26

Disability

67. There is little subject-specific data on uptake and attainment in relation to pupils with special educational needs and disabilities. The SEND Review published by the Department for Education in March 2022 contained a commitment to improve the attainment and other forms of data collected for such pupils.[115]

Overall patterns

68. The data support an assertion by Dr Claire Crawford of the Institute for Fiscal Studies that in terms of uptake and attainment, STEM subjects should not be viewed as a homogenous group, but have been split into distinct categories by contemporary analysts:

> A lot of the evidence now is splitting the STEM subjects into two groups: those that are more maths-based like physics and maths, and those that are more life sciences-based like biology and, a bit more arguably, chemistry. They do see very clear distinctions.[116]

Jane Lunnon, Headteacher at Alleyn's School, a co-educational independent day school in London, told us career choices by girls favoured biology and chemistry, at the expense of physics:

> Many of our girls want to be medics. For a lot of them, that is the pathway they have seen from early on; they are motivated by it and it is a vocation that is calling them. If they want to be a medic, they have to do chemistry and, although they technically do not have to do biology, they are very likely to. It is intuitive to choose biology and chemistry […] Because you have already chosen chemistry and biology, you are not just not being pulled to physics; you are potentially being diverted away from it, because you may well say, "I want to do one other A-level that is not a science".[117]

Data from the Higher Education Statistics Agency underlines this point: female students accounted for approximately 62% of entrants to undergraduate medicine and dentistry courses in 2021/22.[118]

69. Other contributors to our inquiry suggested that the patterns were not unique to STEM subjects. CEPEO said questions around low subject uptake, beyond STEM, by pupils from certain groups could be examined and offered English Literature as an example, which is notable for being less popular among males at A-level than physics is among females.[119]

115 Department for Education and Department for Health and Social Care, SEND Review: right support, right place, right time, 29 March 2022, p. 70
116 Q260
117 Q307
118 Higher Education Statistics Agency, Higher Education Student Statistics: UK, 2021/22 - Subjects studied, 19 January 2023
119 UCL Centre for Education Policy and Equalising Opportunities (DIV0112)

70. **The data on STEM subject uptake and attainment at GCSE and A-level paints a complex picture. There are clear differences between boys and girls, with the latter seemingly less inclined to pursue STEM subjects than the former. The evidence our inquiry received offered no consensus as to the reasons for this difference—preference, consideration of future career prospects, and greater conservatism on the part of boys being suggested causes.**

71. **The picture between and within different ethnic and socio-economic backgrounds is similarly complex, however, pupils from some backgrounds, such as Black Caribbean, are clearly underrepresented across STEM subjects at both GCSE and A-level. Others, such as pupils from Chinese backgrounds, are often well-represented.**

72. **Access, or lack of it, to the separate study of biology, chemistry and physics at GCSE—known as the 'triple science' option—is a decisive factor for many pupils in determining whether they study STEM subjects at university and enter the STEM workforce. If the pool of students studying triple science lacks diversity, this will be reflected in STEM settings later in life. *The Government should in its response to this Report tell us how it intends to ensure more pupils have access to triple science, or how else it proposes to overcome barriers to pursuing an interest in STEM faced by pupils from certain backgrounds.***

The role of inspection

73. Ofsted, the Office for Standards in Education, Children's Services and Skills, inspects services that provide education and skills for learners of all ages.[120] In the context of improving the diversity of STEM subject cohorts, Dr Jasper Green, Her Majesty's Inspector, Schools and Subject Lead, Science, at the Ofsted Curriculum Unit, told us that the quality of education and the curriculum were both important to improving participation:

> We know the importance of an ambitious curriculum that is not narrowed and […] ensuring that it is rich and paints a really authentic understanding of what science is. It is about people learning the true diversity of science, not just fair tests or science that is carried out by males, for example.
>
> We are focusing on the quality of education; we are focusing on early education; we are focusing on subjects. I think all those moves are the rights ones to encourage wider participation at A-level.[121]

74. The importance of inspection was highlighted by some contributors to our inquiry. Professor Dame Athene Donald suggested a more comprehensive picture of subject take-up across different disciplines and characteristics would be useful:

> […] gender equity should be part of an Ofsted inspection: at every stage, what is your school doing? Is it, as Dr Green said, monitoring what is happening? That matters just as much for boys as for girls […] if Ofsted made gender equity an issue, every school—primary schools as well—would have to think, "What are we doing? Without thinking about it, are we giving boys different games to play or different tasks?"[122]

120 GOV UK, Ofsted: About, accessed 25 January 2023
121 Q275
122 Qq. 268, 274

75. Since the conclusion of our inquiry, Ofsted has published a report examining the strengths and weaknesses of science education in primary and secondary schools in England, based on evidence gathered during routine inspections.[123] The report found that "although many pupils leave school with a secure knowledge of science and working scientifically, there are still too many pupils who do not".[124] It highlighted the need for primary pupils to develop:

> […] an accurate and genuine understanding of science, for example knowing that scientific research is not just carried out by men in white coats working in laboratories.[125]

Whilst the report was based on a sample of schools that Ofsted described as "broadly representative of the national picture",[126] it did not contain the type of analysis suggested to us by Professor Dame Athene Donald. It also did not detail levels of uptake and attainment among different groups of children.

76. **We welcome Ofsted's recent report examining science education in primary and secondary schools. However, some contributors to our inquiry suggested that given the importance of inspection, it could do more to encourage diversity and inclusion in STEM education.**

77. ***The Government should tell us whether it has consulted with Ofsted on levels of uptake and attainment among different groups of children, and whether it has discussed an expansion of its inspection criteria to include a more comprehensive picture of subject take-up and attainment across different disciplines and characteristics.***

78. ***Ofsted should, as part of its inspection criteria, gather data and report on levels of subject take-up and attainment among pupils with different characteristics, such as gender, ethnic background and socio-economic background. The latter could utilise Free School Meals eligibility, which is already used in Government education data. Where there are disparities, schools should record and be assessed against the steps they are taking to make subject take-up more representative.***

The role of subject choice

79. In this Chapter we have outlined how some witnesses told us of the importance of the separate study of biology, chemistry and physics by pupils who wish to pursue STEM subjects in their studies beyond GCSE, and the consequences of this option being unavailable. We will now examine the role of subject choice, and the post-16 study of maths and science.

123 Ofsted, Finding the optimum: the science subject report, 2 February 2023
124 Ofsted, Finding the optimum: the science subject report, 2 February 2023
125 Ofsted, Finding the optimum: the science subject report, 2 February 2023
126 Ofsted, Finding the optimum: the science subject report, 2 February 2023

80. In a September 2021 report, the Education Policy Institute found that a reduction in the number of A-levels taken by pupils had led to them pursuing a narrower range of subjects. Between 2016–2019 the average number of post-16 qualifications sat by students fell from five to three. In 2010, 38% of students took subjects from three or more subject groups but by 2019 this had fallen to 17%.[127]

81. One potential solution to the reduced likelihood of pupils from under-represented groups opting to pursue STEM subjects suggested to us was offered by Katharine Birbalsingh, who made the case for removing some choice from pupils, up to a certain age:

> What I would say is that you need to give fewer choices so that children are guided into the right sorts of things for them, at a lower age […] When it comes to A-level and so on, they are sort of old enough then to be able to make the choices […] we don't go around saying to the girls, "Come on, take physics!" I want them to do the things that they want to do and that's that. The younger they are, the fewer choices you give and the more scaffolding you give. Then, gradually, as they get older, you take that away.[128]

Jane Lunnon told us that she was in favour of making post-16 STEM qualifications compulsory, as part of changes to broaden the post-GCSE curriculum.[129] Clare Hayes, deputy head at Hyndland Secondary School in Glasgow, and Mark Turner, headteacher at Skipton High School for Girls, were less convinced of the necessity and benefits of compulsion, even if it was designed to target under-representation, although the latter expressed support for a broader post-16 curriculum.[130]

82. Clare Hayes also told us that the options available to pupils at her school—which operates the Scottish 'Highers' assessment system—were broader, and that greater breadth of study until the age of 18 had encouraged greater take-up in STEM subjects:

> […] we offer eight qualifications at national 5: English, maths, and we would ask young people to pick at least one science subject, at least one technology, at least one creative or aesthetic subject—I am missing one—and then they get two extra choices […] Then, when they get to the end of S4, when they have completed their national qualifications at national 5 level, they get the opportunity to pick five in fifth year.
>
> […] We frequently have them picking three independent sciences, and particularly young people who have an aspiration to do medicine would want to do three sciences at national 5. They might only do two of them in fifth year, but then they might come back to do physics again in sixth year, so they kind of get two bites at the cherry there.[131]

83. Dr Green of Ofsted said research had found a correlation between choice and pupils being more susceptible to conscious and unconscious messaging and suggested having a choice could lead to pupils from under-represented groups believing that science was

127 Education Policy Institute, A narrowing path to success? 16-19 curriculum breadth and employment outcomes, 14 September 2021, pp. 16-17

128 Q217

129 Q326

130 Q309

131 Qq. 322-324

not the right option for them.[132] Nevertheless, he was not in favour of introducing any additional compulsion into a system that already contained this element up to the age of 16 years old.[133] Robin Walker MP, the then Minister for School Standards, was also not in favour of compulsion:

> […] it is really important that people have the opportunity to choose and to specialise […] maths is the most popular A-level—when we have choice, it is popular […] It is important that we look at how we incentivise, but it should always be a matter of choice.[134]

84. Since our inquiry concluded, the Prime Minister has set out his ambition "to move towards all children studying some form of maths to 18", but also ruled out compulsion at A-level, and that additional options would be available to students.[135] The Government has said it will set out further details in due course.[136]

Post-16 study of maths and science

85. Options for post-16 study of maths and sciences were suggested by some contributors to our inquiry. Professor Ulrike Tillman of the London Mathematical Society said that she was in favour of a wider package of reforms that as well as introducing some compulsion, broadened A-level content and promoted Core Maths.[137] Core Maths was introduced in 2014 as a non-compulsory post-GCSE additional qualification, for students who had achieved a maths GCSE but not chosen the subject at AS or A-level. Usually taken over two years, it prioritises the application of mathematical skills to overcome real-life challenges at university, in the workplace and beyond, and is now part of the Government-funded Advanced Mathematics Support Programme (AMSP).[138]

86. Professor Paul Glaister, Professor of Mathematics and Mathematics Education at the University of Reading, who was involved with the development of Core Maths, has described it as a vital tool in helping young people realise their ambitions.[139] Paul Kett, Director General for Skills at the Department for Education, told us that the Government was actively promoting the AMSP, and that approximately 12,000 people had signed up in the 2021 application window.[140]

87. Following the Prime Minister's January 2023 speech, the Government has confirmed that it is considering how Core Maths can help deliver the Prime Minister's ambition to increase the study of maths, "as well as more innovative options".[141]

88. ***The Government should in its response to this Report set out how it intends to deliver on the Prime Minister's stated ambition.***

132 Q256
133 Qq. 288–289
134 Q366
135 GOV UK, Prime Minister's speech on building a better future, 4 January 2023
136 GOV UK, Prime Minister sets ambition of maths to 18 in speech, 4 January 2023
137 Qq. 356, 360
138 Advanced Mathematics Support Programme, Studying maths beyond GCSE, accessed 28 July 2022
139 Royal Society, We need to support Core Maths qualifications to realise young people's ambitions, 27 January 2022, accessed 28 July 2022
140 Qq. 393-394
141 GOV UK, Prime Minister sets ambition of maths to 18 in speech, 4 January 2023

89. ***We recommend as an alternative to compulsion the introduction of a requirement for pupils who do not continue with a STEM subject post-16 to take the Advanced Mathematical Support Programme or a Core Science course. Core Science could be developed using the same applied principles as Core Maths and the Advanced Mathematical Support Programme.***

STEM teaching workforce

90. We will now turn our attention to the teaching workforce responsible for imparting that content. We will consider the diversity of the workforce, subject specialist availability, recruitment and retention.

The benefits of subject specialists

91. Dr Rebecca Montacute, of the Sutton Trust, suggested there was a link between subject expertise and teacher effectiveness, and that STEM-qualified staff would make a particular difference at schools in disadvantaged communities.[142] As discussed below, Russell Hobby, Chief Executive of Teach First, told us that such schools were, however, less likely to attract STEM teachers with degree-level qualifications.[143] Dr Montacute detailed the positive impact of being taught by subject specialists on pupil attainment:

> […] we know that those with subject expertise are strongly linked to how effective they are as teachers in that specific subject, which will then feed into the attainment of young people. That in and of itself feeds into how likely they are to be able to go on in terms of their attainment.[144]

The benefits of subject specialists were highlighted by the teachers that we heard from during our inquiry. Claudenia Williams of the Kingsley Academy said they were particularly important for key stage 3 pupils:

> [that] is a real opportunity for students to build significant depth and knowledge […] We do need subject specialists who can go into depth and detail so that students can build on that knowledge. What we know about learning and how it works means that we need to pay attention to early years, probably even before key stage 3, so I still don’t think it is good enough not to have a specialist teacher in front of students. They deserve to have that.[145]

Mark Turner, headteacher of Skipton High School for Girls, said that subject specialists, particularly those with industry experience, were more able to take advantage of external resources and draw upon their career experience to better engage students.[146] Jane Lunnon agreed that school leaders should always aim to recruit STEM-qualified teachers.[147]

142 Q92
143 Q106
144 Q82
145 Q121
146 Q302
147 Q318

92. Contributors to our inquiry also said that while schools are sometimes required to adapt according to availability—for example by having existing, non-specialist staff provide cover—this was not the preferred option. Russell Hobby explained why:

> On a temporary basis, teachers can step in to help, and do so on a regular basis, but if you want people to choose careers in these areas, or further education, what you also want is someone who clearly loves the subject they are teaching and thinks that physics is the most amazing thing in the world. I think it is the teacher's inspiration that steers young people in particular directions. I think they choose A-levels as much on the basis of the teacher who is going to teach them as on the subject itself.[148]

Clare Hayes told us that subject expertise did not just benefit pupils, but that it also led to a more confident workforce, and that she had observed the effects of subject specialists being unavailable.[149]

93. Robin Walker MP, the then Minister for School Standards, acknowledged the benefits of subject specialist teachers, but highlighted longstanding shortages:

> […] we have to be honest about the fact that we have struggled over a decade—this is not a new thing—to recruit sufficient subject specialists in physics. We therefore need to make sure that we can deploy some of the scientific expertise from other areas into the teaching of physics and of science more generally. We also need to look at how we tackle the conundrum that we do not have enough people specialising in physics at A-level partly because we do not necessarily have enough specialist teachers earlier on.[150]

Continuing professional development

94. We also heard that continuing professional development (CPD) could help raise teaching standards and ensure the curriculum was delivered in a way that emphasised diversity and inclusion. Professor Dame Athene Donald said CPD would help improve the overall environment in schools, and encourage greater diversity:

> […] good confident teachers also contribute significantly to schools that are diverse, inclusive welcoming places to learn. High-quality teachers who are subject specialists are better able to counter myths about pursuing STEM learning or careers as only being viable for certain groups and help to ensure that all students who wish to can access the full repertoire of science courses […] for science teachers in particular, it is crucial that they have the opportunity to refresh their subject content knowledge at regular intervals since it is such a fast-moving field.[151]

148 Q122
149 Q320
150 Q379
151 Professor Dame Athene Donald (DIV0111)

Mark Turner agreed CPD would be particularly helpful in primary schools,[152] while the Institute of Physics called for revised teaching standards, accompanied by the appropriate CPD.[153] Dr Diane Harris of the Manchester Institute of Education at the University of Manchester suggested that it could be delivered in partnership with STEM organisations and industry.[154]

95. Robin Walker MP, the then Minister for School Standards, said that the Government had introduced subject knowledge enhancement funding to help improve teacher expertise. He also emphasised the importance the Government placed on CPD and other forms of staff support.[155]

96. **There are clear benefits when children are taught by teachers with qualifications, professional experience, or specialism in those subjects.** ***The Government should set a target for every child to be taught STEM subjects by teachers with qualifications in that subject by the end of the decade. Teachers should be given access to improved, mandatory continuous professional development to ensure their knowledge remains up to date—which is particularly important in STEM subjects where there are new discoveries and developments on a regular basis.***

Teaching workforce diversity

97. Research has suggested that the diversity of the teaching workforce across all subjects does not reflect that of pupils: the UCL Institute of Education found that in 2019, 65.4% of pupils were from a White British background, compared to 85.6% of teachers.[156] The Hamilton Commission has calculated that 15,655 additional black teachers would be needed to bring teacher diversity in line with that of pupils.[157]

98. Teach First told us that action was required to make the teaching workforce more diverse, and this would help improve pupil attainment.[158] Teach First also detailed its partnership with Mission 44, a foundation established by Sir Lewis Hamilton, which began in October 2021 and aimed to support the recruitment and training of more black STEM teachers, particularly in disadvantaged communities.[159]

99. Claudenia Williams of Kingsley Academy said that support for teachers from under-represented groups would help them respond to challenges in the classroom and beyond:

> If we are saying that we want to have greater diversity in our schools in STEM, we need to ensure that these teachers stay in the profession, that they have the support to stay in that profession, and that it feels like a safe place to be and to grow, knowing that they can hold those roles and lead schools and are supported to do so.[160]

152 Q336
153 Institute of Physics (DIV0033)
154 Dr Diane Harris, Manchester Institute of Education, the University of Manchester (DIV0011)
155 Q379
156 UCL Institute of Education, Making progress? Employment and retention of BAME teachers in England, 14 December 2020, p. 3
157 The Hamilton Commission, Accelerating Change: Improving Representation of Black People in UK Motorsport, 13 July 2021, p. 105
158 Teach First (DIV0037)
159 Teach First, Mission 44, accessed 18 January 2023
160 Q125

Teacher shortages and recruitment challenges

100. The House of Lords Science and Technology Committee has said the UK has "a severe, long-standing shortage of specialist science teachers, especially in high-demand subjects like physics and computing".[161] Sam Freedman, a former Department for Education adviser and Senior Fellow at the Institute for Government, said maths and physics teachers have long been among those most in demand:

> You can earn a lot more as a graduate with a STEM degree […] at this point, even if we recruited two thirds of everyone doing a physics degree into teaching, we would only just hit the target. There is not a very big pool and a very big number that you are trying to reach […] if you cannot get the teachers, fewer people will study the subjects to a level where they are comfortable doing a degree. We are in a bit of a vicious circle when it comes to recruitment […][162]

Mark Turner told us that the perception of a school's quality had an impact on their ability to recruit, and that this was directly influenced by Ofsted ratings.[163]

101. The National Foundation for Educational Research has found that although the number of applicants for initial teacher training (ITT) rose in 2020 and 2021, this was not enough to meet targets for several STEM subjects. They also forecast a return to "a more challenging overall teacher recruitment environment" following the covid-19 pandemic.[164]

Student loan repayments

102. Since 2017 some biology, chemistry, computing and physics teachers have been able to reclaim student loan repayments made during their time in teaching. Eligibility is based on the subject taught, the amount of time spent doing so, the local authority area where their school is located, whether the individual is currently employed at a state-funded secondary school in England, and their ITT completion date.[165]

103. Sam Freedman argued that the Government should address costs associated with teacher training, specifically:

> […] scrap the need to get a loan to do a PGCE, or to do any training […] Your average teacher will never earn enough to pay back both an undergraduate loan and a post-graduate loan, so there is no financial benefit to the Government from demanding that people take out a loan, yet it still puts people off doing a PGCE—it is doubly pointless […] that is just a very obvious thing that you could do, with very little cost, which would make it a lot more attractive for people to go into teaching and, obviously, from more underrepresented backgrounds in particular.[166]

161 Correspondence from the House of Lords Science and Technology relating to its inquiry into people and skills in UK STEM, 15 December 2022
162 Q112
163 Q315
164 National Foundation for Educational Research, Teacher Labour Market in England: Annual Report 2022, 23 March 2022, p. 8
165 Gov.uk, Teachers: claim back your student loan repayments, guidance, accessed 18 January 2023
166 Q124

When we put this suggestion to the then Minister for School Standards, Robin Walker MP he was unconvinced of the case for such a move:

> There has been very little evidence that the loans actually disincentivise people from entering the profession. It is important that the loans are treated consistently with other higher-education loans […] It would not necessarily be right to treat the teaching workforce as entirely different from other areas that benefit from tertiary education.[167]

Early-career payments, the Levelling Up Premium and other incentives

104. Early-career payments of £2,000 or £5,000 are available up to the 2024–25 academic year for teachers who started (postgraduate) or finished (undergraduate) their initial teacher training between 2018–2021 in maths, and 2020–2021 in chemistry and physics.[168] The Government has also increased these payments to £3,000 and £7,500 for teachers in certain local authorities, known as uplift payment areas.[169]

105. In May 2022, the Government announced that under the Levelling Up Premium, chemistry, computing, maths and physics teachers in eligible schools would receive payments of up to £3,000 per year until the 2024–25 academic year; if they were in their first five years of teaching and teaching at state-funded secondary schools. Teachers at schools in 55 local authorities designated as Education Investment Areas are eligible to receive the full £3,000. Teachers can claim one of the early-career payments or Levelling Up Premium, in conjunction with the student loan repayment.[170]

106. In October 2022, the Government announced that prospective chemistry, computing, maths and physics teachers beginning their initial teacher training in September 2023 would be eligible for bursaries worth £27,000 and scholarships worth £29,000. For physics, both UK and non-UK nationals will be eligible.[171]

107. The school leaders we heard from during our inquiry had generally positive views of the bursaries but questioned whether they would be enough to make a difference. Mark Turner highlighted the need for a pipeline of talent entering the profession.[172] Research has also suggested that bursaries may not be sufficient to eliminate STEM teacher recruitment challenges. Scenario-modelling by the National Foundation for Educational Research in a 2022 study reached a clear conclusion for computing and physics:

> Physics and computing are highly unlikely to meet their respective recruitment targets under any package of measures. Combinations of additional financial measures could support the improvement of teacher supply in physics and computing, but no reasonable set of measures are compatible with the current target being met.[173]

167 Q384
168 Gov.uk, Early-career payments guidance for teachers, accessed 18 January 2023
169 Gov.uk, Early-career payments guidance for teachers, uplift areas, accessed 18 January 2023
170 Gov.uk, Teacher bonuses and funding for schools to level up education, accessed 18 January 2023
171 Gov.uk, Boost for teacher training bursaries by up to £10,000 a year, accessed 18 January 2023
172 Q327
173 National Foundation for Educational Research, Assessing the impact of pay and financial incentives in improving shortage subject teacher supply, 23 June 2022, p. V

Robin Walker MP, the then Minister for School Standards, told us that the bursaries represented a comprehensive response to recruitment and retention challenges "over a number of years and with an incentive to get the teachers to where they are most needed".[174] The then Minister accepted that bursaries were unlikely to solve the problem on their own but said that they should be viewed as part of a wider package.[175]

108. **STEM teacher salaries must be as competitive as possible with the private sector, and we welcome the new STEM-focused bursaries and wider efforts by the Government to recruit and retain STEM teachers. However, we do not think the amounts currently on offer will prove anywhere near sufficient to address longstanding shortages, particularly in subjects such as computer science and physics. The fact that such a significant proportion of current university graduates in STEM subjects would be needed to address the shortfall underlines the scale of the challenge.**

109. ***The Government should assess the impact of further salary increases on recruitment targets for STEM subjects with particularly acute shortages; and detail its findings in its response to this Report. It should also tell us what further interventions are planned for subjects where recruitment targets are unlikely to be met, whether it has undertaken any assessment of the impact that increased numbers of STEM graduates from university courses would have of teaching workforce shortages, and whether it has any plans to grow the number of STEM graduates entering the teaching workforce.***

Attracting STEM professionals to teaching

110. The then Minister also told us that the Government had responded to staff shortages by partnering with the engineering sector through the Engineers Teach Physics programme to increase the number of new ITT recruits with industry backgrounds or experience.[176] Following a pilot, the scheme has been extended nationally for the 2023–24 recruitment cycle.[177]

111. Jane Lunnon highlighted other efforts to bring professionals into the classroom, such as the work of organisations such as Now Teach, a charity established by Lucy Kellaway, a former journalist at the Financial Times, which supports late-career professionals through the teacher training process.[178] Jane Lunnon emphasised the potential of such initiatives:

> […] it absolutely makes sense to try to incentivise people as best you can to get the best talent in front of kids […] so that people who have been eminent in their careers, like many of you, come back into the classroom for the last four or five years of their working life […] The question is how we can solve the teaching crisis without just waiting for people to be recruited into teaching and so on.[179]

174 Q375
175 Q382
176 Q379
177 Department for Education, Offer an engineers teach physics course: guidance, accessed 18 January 2023
178 Now Teach, Our network and programme, accessed 18 January 2023
179 Q329

112. **We welcome the Government's nationwide roll-out of a scheme with the engineering sector, designed to increase the number of Initial Teacher Training recruits with industry experience.** ***The scheme should, subject to evaluation, be expanded to bring more STEM professionals into classrooms to help teach other subjects where there are shortages.***

113. ***The Government should consider what support it could offer to initiatives such as Now Teach, which draw upon experienced professionals to help meet STEM teacher recruitment challenges and to inspire a more diverse range of pupils to continue with STEM subjects.***

4 STEM research institutions

114. Having examined the importance of education in shaping the demographics of those entering the STEM workforce in Chapter 3, we will now consider STEM research institutions. We will offer a snapshot of the situation experienced by certain groups; and examine what role UK Research and Innovation (UKRI), other research funders and the Government could play in improving diversity and inclusion.

STEM research institutions

115. Some contributions to our inquiry from those in STEM research roles made for sobering reading. Dr Emma Yhnell, a lecturer in Neuroscience at Cardiff University, told us "systemic diversity and inclusion issues" continued to cause her to question whether an academic career in science was right for her.[180]

116. Dr Mark Richards, a senior teaching fellow at Imperial College London, shared anonymised responses from a survey undertaken by the Blackett Lab Family, a collective of UK-based black physicists. One respondent currently undertaking a PhD said they had yet to meet a black supervisor and that, across the entire four-year cohort, there were two other black men and no black females.[181]

117. Some contributors to our inquiry pointed to the 'attrition' of certain groups in STEM academia, whereby at each stage of the journey from higher education into doctoral, postdoctoral and senior research roles, their presence decreases. The Careers Research and Advisory Centre (CRAC) summarised the situation as follows:

> There is a patchwork of information about different segments and very little connectivity between the datasets that do exist, outside higher education. What we can see, however, is that within almost all those segments, there are profiles that suggest one or all of the groups mentioned are under-represented in some way, but not always in the same way.[182]

118. Katherine Mathieson, then Chief Executive of the British Science Association, cautioned against using the 'leaky pipeline' analogy, which is often used to describe the situation:

> I see the appeal of that metaphor and it can be useful, but it suggests that the people responsible for the attrition are the people who are leaking out at each stage, and that they do not find science or STEM sufficiently interesting, appealing or worthwhile, and they leak out of the pipeline. If we look at it as a system in which the barriers are higher for less privileged groups in society, and each time there is a decision point we see the effects of those barriers more clearly for some groups than others, that frames it as a societal-wide issue.[183]

180 Dr Emma Yhnell (DIV0070)
181 The Blackett Lab Family C.I.C (DIV0075)
182 The Careers Research & Advisory Centre (CRAC) and Vitae (DIV0050)
183 Q52

Gender

119. Data compiled by the Higher Education Statistics Authority (HESA) reflects, as would be expected, trends visible at GCSE and A-level, wherein the number of males studying computer science, mathematical sciences and physical sciences throughout higher education is greater than the number of females; and the reverse is true of biological sciences, dentistry and medicine.[184] Clare Viney, CRAC Chief Executive, told us:

> At each transition, there is attrition and drop-off for many reasons, and it is not the same; it is different by discipline […] If you look at STEM, the totality is relatively good. If you then look at physics and you drill down, it becomes worse. About 20% of undergraduates take physics. It is a pyramid. With biological sciences, you start with a large number, and you continue with a largeish number, so that attrition is not quite so stark.[185]

Professor Jeremy Sanders of the Royal Society made a similar point:

> The attrition in physics is very obvious because you start out with relatively few women. If you halve them and then quarter them, it is very obvious. In biology, because you start off with more than 50% women, the attrition still leaves you with a substantial number of senior women.[186]

120. Contributors to our inquiry highlighted the presence of attrition in their particular disciplines:

- Clare Viney, CRAC, highlighted HESA data for biological sciences: at postdoctoral researcher level, women accounted for 57% of the UK-domiciled total; but at professor level, the percentage fell to 29%;[187]
- Clare Viney also highlighted HESA data for physics: at postdoctoral researcher level, women accounted for 21% of the UK-domiciled total; but at professor level, the percentage fell to 10%;[188]
- The Royal Statistical Society, The Institute of Mathematics and Its Applications and the London Mathematical Society Committee for Women and Diversity in Mathematics, told us that only 11% of UK maths professors are female, even though they comprised 37% of the total number of students enrolled in mathematical sciences in the 2019/20 academic year.[189]
- Chemistry is similarly affected: the Royal Society of Chemistry (RSC) said women accounted for just 18.4% of permanent academic contract holders, and, within that, only 9% of the total number of professors, although the RSC has also found evidence of a younger cohort of professors emerging, a positive trend.[190, 191]

184 Higher Education Statistics Authority, HE student enrolments by CAH level 1 subject and sex 2019/20 to 2020/21, accessed 18 January 2023
185 Qq. 34-35
186 Q37
187 The Careers Research & Advisory Centre (CRAC) and Vitae (DIV0102)
188 The Careers Research & Advisory Centre (CRAC) and Vitae (DIV0102)
189 The Royal Statistical Society, The Institute of Mathematics and Its Applications and the London Mathematical Society Committee for Women and Diversity in Mathematics (DIV0087)
190 Royal Society of Chemistry (DIV0032)
191 Royal Society of Chemistry, Diversity landscape of the chemical sciences, 15 February 2018, p. 20

121. Contributors to our inquiry highlighted initiatives such as the Athena Swan Charter, a framework launched to improve gender equality in higher education. However Professor Dame Athene Donald,[192] the Daphne Jackson Trust,[193] and Professor Alice Sullivan[194] all said that despite the positive impact and intentions behind these efforts, there remains work to be done.

Ethnic background

122. CRAC described the picture in relation to ethnic background as "much more nuanced".[195] The Royal Society highlighted work they had commissioned to identify the extent of the disparities, which found:

> […] significant variation in rates of progression and outcomes across ethnic minority groups, though Black staff and students have consistently poorer outcomes than white and Asian students. The proportion of Black students entering undergraduate and postgraduate education has increased over the past decade, as it has for other minority ethnic groups, but they are leaving STEM in greater numbers at all stages of the career pipeline.[196]

123. Contributors to our inquiry provided the following snapshots of the situation in their disciplines:

- The British Neuroscience Association told us demographic data from their 2021 events showed Asian or Asian British delegates and speakers were over-represented compared to the general population—11% to 8%.[197]
- CRAC's submission to our inquiry illustrated "attrition along the progression path of UK domiciled Black scientists, who comprise:#
  - 8% of undergraduates
  - 2.2% of PhD students
  - 1.4% of postdoctoral/research staff
  - 1.4% of lecturers or research fellows
  - 0.7% of Readers or research leaders
  - 0.4% of Professors".[198]
- As is the case with gender, CRAC told us that the figures for physics specifically were even smaller:

192 Professor Dame Athene Donald (DIV008)
193 The Daphne Jackson Trust (DIV009)
194 Professor Alice Sullivan (DIV0049)
195 The Careers Research & Advisory Centre and Vitae (DIV0050)
196 The Royal Society (DIV0015)
197 British Neuroscience Association (DIV0051)
198 The Careers Research & Advisory Centre (CRAC) and Vitae (DIV0050)

- "In the 2018/19 data, using the filtering we applied for postdoctoral researchers, only one Black male UK postdoc in physics is identified (which should be rounded down to zero). A wider definition of postdoctoral researcher could increase this to a handful at most.
- Equally, there appears to be a sole Black Professor (the only one being male and of UK domicile) in the 2018/19 staff population".[199]

- The Institute of Physics told us that of physics staff in higher education in the 2019/20 academic year:
  - 84% reported their ethnicity to be a white background;
  - 4% of the HE physics workforce reported their ethnicity to be Chinese;
  - 4% reported their ethnicity to be Asian or Asian British–Indian.
  - 2% reported their ethnicity as Other Asian Background;
  - 1% reported their ethnicity as Black; and
  - 5% reported their ethnicity as Mixed or Other".[200]

Disability

124. Professor Jeremy Sanders said challenges associated with disclosure arose for different reasons and the disability disclosed often varied.[201] Clare Viney, Chief Executive of CRAC, agreed, and said the context of how the disclosure was made was an important variable.[202] The Royal Society also pointed out that the absence of a single definition of what constitutes a disability made analysis of disclosure data more complex.[203]

125. The Royal Society also said that between 2018–2020, 3–5% of applicants to their three early career research fellowship programmes declared themselves as having a disability.[204] This reflected previously commissioned research, which found that although the percentage of STEM academic staff with a known disability had increased from 2% in 2007–8 to 3.8% in 2018–19, the percentage of academic staff with a known disability was lower for staff working in STEM than non-STEM.[205]

The working environment

126. Contributors to our inquiry described barriers to participation in research activity, particularly for researchers with disabilities. Professor Jeremy Sanders of the Royal Society told us making laboratories more accessible was an expensive, complex undertaking, but that it was possible.[206] He also said accessibility and inclusivity should be central to facility design:

199 The Careers Research & Advisory Centre (CRAC) and Vitae (DIV0102)
200 Institute of Physics (DIV0033)
201 Q5
202 Q9
203 Royal Society (DIV0015)
204 Royal Society (DIV0015)
205 Royal Society (DIV0015)
206 Qq. 11-13

> The involvement of wheelchair-using students in developing lab designs […] strongly suggest that the emphasis in STEM workplaces should be on 'inclusive design', not only 'reasonable adjustments'. Making inclusive design a starting principle for STEM workplaces would help to ensure that accessibility and inclusion are considered from the outset, not as an afterthought.[207]

Dr Jasleen Jolly of the National Association of Disabled Staff Networks (NADSN) emphasised that support should be tailored, as accessibility encompassed a wide range of requirements, and that it should consider sensitivity to noise or light, or a need for height-adjustable desks.[208]

127. ***The Government, UK Research and Innovation and other research funders should make funding available for research facilities undertaking reasonable adjustments to ensure they are fully accessible.***

128. Others, such as the Royal Society of Chemistry and Society for Applied Microbiology, highlighted an expectation for individuals from under-represented groups to help address the consequences of under-representation at organisational level—for example, by taking part in one-off initiatives or sitting on Diversity Committees—in addition to their day-to-day duties. They said this could lead to overworking and in some cases burnout, driving people away from STEM roles.[209]

129. **Some STEM researchers face a discriminatory working environment. Whilst this reflects inequities that exist elsewhere in society it is nevertheless a source of deep concern. The process of reducing and ultimately ending such prejudice will not be swift but is vitally important.**

Contractual conditions

130. Professor Rachel Oliver of the Inclusion Group for Equity in Research in STEMM (TIGERS) and the University of Cambridge told us that precarious contractual conditions are "a problem for everybody, but it is specifically problematic for a number of under-represented groups",[210] whilst Clare Viney told us that 70% of contracts in higher education roles were short-term,[211] and Dr Jolly of NADSN said she had experienced a succession of short-term contracts.[212]

131. The challenge for researchers returning from career breaks, for example due to parental leave or caring reasons, was highlighted by the Daphne Jackson Trust (DJT), which supports returners from a career break of two or more years taken for family, caring or health reasons. DJT said that career breaks could have significant negative effects:

> Highly qualified and skilled individuals that temporarily step back from their research area can find themselves lagging behind their peers due to a lack of recent research outputs, being perceived as 'behind the curve' in

207 Royal Society (DIV0104)
208 Q206
209 Royal Society of Chemistry (DIV0032), Society for Applied Microbiology (DIV0028)
210 Q176
211 Q36
212 Q206

> knowledge and technical skill and a lack of self-confidence. When seeking to return to work, they often struggle to find research-based employment that fully utilises their knowledge and experience. Many leave their preferred profession entirely or are forced to take jobs outside of their area of expertise and below their skill level.[213]

Professor Dame Athene Donald of the University of Cambridge also highlighted the impact of the current system on early career and female researchers and argued that significant reforms were required. She said these should address the funding landscape as well as institutional behaviours.[214]

132. **Our inquiry received evidence that highlighted the importance of addressing as a matter of urgency the precarious nature of many contracts in STEM academia. We examined these issues in greater depth as part of our inquiry into reproducibility and research integrity.**

UKRI and other research funders

133. An independent review of UKRI published in July 2022 said that in addition to its funding responsibilities, the organisation could be a convening and facilitating force across the STEM research ecosystem.[215]

134. In 2019, our predecessor Committee requested data from UKRI on applications for research funding, success rates and amounts awarded, broken down by age, gender, disability and race.[216] UKRI has since published data on the diversity of funding applicants and recipients for each research council from 2014–15 onwards,[217] and has acknowledged the data show that despite rising numbers of female applicants, and those from an ethnic minority background, disparities remained for underrepresented groups applying for and securing funding.[218]

135. Professor Dame Ottoline Leyser, Chief Executive of UKRI, argued that existing inequities were a complex challenge that in part reflected the demographics of the wider research ecosystem:

> In the context of gender, where there has been the most work over the years and we have the best data overall […] there are indeed fewer women applying for funding than one might expect. There is, with the exception of one of our research councils, no evidence that they are less likely to receive funding. We have equal success rates in virtually all the research councils. They are indeed likely to apply for fewer large awards, which is very skewed by the fact that the really big grants—for example, large doctoral training accounts that are running a big cohort of PhD student training activities—are typically disproportionately run by men.[219]

213 Daphne Jackson Trust (DIV0009)
214 Professor Dame Athene Donald, DBE FRS (DIV0008)
215 Department for Business, Energy and Industrial Strategy, UKRI Independent Review: Final Report and Recommendations, 20 July 2022, p. 33
216 Correspondence from the then Chair to Sir Mark Walport, then Chief Executive of UKRI, regarding the impact of science funding policy on equality, diversity, inclusion and accessibility, 9 September 2019
217 UK Research and Innovation, Diversity data, accessed 18 January 2023
218 UK Research and Innovation (DIV0084)
219 Q451

Research Council Committees

136. Professor Narender Ramnani, a professor of Neuroscience at Royal Holloway, University of London, provided to us his analysis of two freedom of information requests submitted to UKRI, covering five financial years of data from six research councils (RC) and 1,337 meetings. His findings included:

- Over any given year, for any given RC, committee places taken up by ethnic minority participants ranged from 3% to 13%;
- In one RC, there were no committee attendees who disclosed their ethnicity as Black over the five-year period;
- Across six RCs, over five years, about half of all committee meetings contained no participants who disclosed their membership of an ethnic minority.[220]

When we asked Professor Dame Ottoline Leyser how UKRI had responded to Professor Ramnani's findings, she told us that action was being taken and progress was being made:

> […] we are year on year improving and expanding the data that we are collecting and publishing. Open publication of those data is crucial […] including those peer-reviewed data in that overarching dataset is one of the things we are proposing to do so that that is absolutely out there and transparent. Every council is putting in place an action plan to address the issues that have been identified across the EDI spectrum, and those are council-specific plans because […] the issues are very different in different councils, and they need specific plans to address them.[221]

137. In January 2022 UKRI published its first draft Equality, Diversity and Inclusion (EDI) strategy. UKRI told us the final version will complement ongoing initiatives, including strengthening data collection and analysis; working across UKRI–sharing insight and learning; engagement and listening to the community; demystifying STEM and STEM careers; and greater use of resume for research and innovation narrative CVs (R4RI).[222] UKRI said the latter offered an alternative to the traditional format:

> [that] will allow people working across the research and innovation sector to evidence a wider range of activities and contributions. The traditional academic CV rewards and recognises a narrow set of criteria, for example publications and grant income. This narrowing of what is visible and valued restricts diversity. The narrative format allows better description of varied career pathways, reduces focus on continuous productivity, and enables a broader range of people, ideas and outputs to be highlighted.[223]

138. The use of narrative CVs, both by UKRI and the Royal Society in the form of its Resume for Researchers initiative, was highlighted as a tool to drive greater diversity of grant applicants by contributors to our inquiry, as it allowed applicants space to highlight

220 Professor Narender Ramnani, Professor of Neuroscience at Royal Holloway University of London (DIV0093)
221 Q452
222 UK Research and Innovation (DIV0084)
223 UK Research and Innovation (DIV0084)

activity beyond publications—such as outreach activity, which is vital to cultivating diverse future talent. Clare Viney, Chief Executive of CRAC, told us narrative CVs had the potential "to be quite revolutionary".[224]

139. Professor Dame Ottoline Leyser told us that although the use of narrative CVs was still at an early stage and its impact could not yet be fully evaluated, UKRI hoped it would counter the prioritisation of certain areas of research activity, input, output and contribution.[225]

140. **We welcome the move towards alternative processes such as narrative CVs and hope to see them become the norm in STEM research funding calls, subject to evaluation.**

UKRI funding and future strategy

141. In addition to its EDI strategy and new application assessment methods, UKRI told us that the May 2022 announcement of its first multi-year funding settlement would allow it to embed key principles, including diversity, across its whole portfolio of work. Professor Dame Ottoline Leyser outlined how the new settlement would help improve diversity:

> […] we are thinking about this as a portfolio of investment with diversity in all its forms as an absolutely core principle, that is how you wind up supporting the full range of activity of people and so on that we need […] in an attempt to support EDI we have spectacularly dumbed down our assessment of excellence to be on a far too narrow range of things trying to force everybody through the same very narrow doorway rather than trying to think about what we need for the system as a whole and how we can support that difference and value that difference in contributing to the overall system.[226]

142. **UKRI must use the publication of its Equality, Diversity and Inclusion (EDI) strategy, and the multi-year funding settlement from Spring Budget 2022, as a launchpad to promote diversity and inclusion across the research sector.** ***The final version of UKRI's EDI strategy must set out a timetable to implement processes to determine, monitor, publicly report against, and ultimately meet targets to reduce underrepresentation in funding awards and decision-making bodies, including its leadership and Research Council Committees panels/boards.***

143. ***Guidance to all Research Council staff should include a specific requirement to ensure representative Committees—for example, greater diversity could be achieved by appointing on potential, rather than on past achievements.***

The STEM workforce beyond academia

144. Although analysis of the wider UK workforce is by definition complex and subject to many factors, contributors to our inquiry did provide a snapshot of the situation for some groups employed in non-academic, STEM-related roles.

224 Q43
225 Qq. 455–456
226 Q461

- Engineering UK told us that in mid-2021 16% of workers in core and related engineering occupations were women compared with 47% of the overall UK workforce;[227]

- The Engineering Construction Industry Training Board said that 0.6% of its workforce identified as being from a black, African, Caribbean, or Black British background, despite them comprising 3% of the UK population, and that individuals from a white background accounted for between 93–97% of the total;[228]

- techUK also said that whilst workers from a non-white background were on average better-qualified than their white peers, the latter were more likely to be managers or supervisors;[229] and

- 7% of respondents to the Institute of Physics' member diversity survey said their parents held no qualifications, and 55% had at least one degree—both indicators of socio-economic status.[230]

145. The Committee may return to the situation beyond the academic STEM workforce in greater depth in the future, given the main focus of this Report has been the situation in academic or research roles.

The impact of covid-19

146. We referred in Chapter 1 to the significant impact of the covid-19 pandemic on the UK labour market, and several contributors to our inquiry described how it had affected diversity and inclusion in STEM workplaces. Equality, Diversity and Inclusion in Science and Health (EDIS) said the pandemic had exacerbated existing inequalities, but also opened the door to potentially beneficial adaptations.[231]

147. Clare Viney, CRAC Chief Executive, was among those to point out that the pandemic had also created opportunities to improve diversity and inclusion:

> […] applications to medicine are up 25%. How do we capitalise on the brilliant narrative, the part that STEM has played, in the pandemic and in the response, not just here in the UK but globally?[232]

148. The impact of the pandemic has also been highlighted by the Government. The Research and Development Roadmap, published in July 2020, said the research ecosystem should harness the positive behaviours it had encouraged, such as collaboration, the sharing of knowledge and support for colleagues.[233] George Freeman MP, Minster for Science, Research and Innovation, told us the challenge would be harnessing the benefits whilst also maintaining the in-person interactions that characterised high-quality research.[234]

227 Engineering UK (DIV0020)
228 Engineering Construction Industry Training Board (DIV0077)
229 techUK (DIV0089)
230 Institute of Physics (DIV0033)
231 Equality, Diversity and Inclusion in Science and Health (DIV0094)
232 Q38
233 Department for Business, Energy and Industrial Strategy, UK Research and Development Roadmap, 1 July 2020, p. 20
234 Q458

Realising the benefits of diversity and inclusion

149. Many contributions from industry and representative bodies detailed organisational reforms, codes of conduct, frameworks, campaigns, and other initiatives intended to promote diversity and inclusion. BCS, the Chartered Institute for IT, said that championing diversity and inclusion was an organisational priority,[235] whilst the Royal Academy of Engineering has co-produced guidance and toolkits on inclusive recruitment practices, building and maintaining inclusive culture, setting targets and monitoring progress, and reducing gaps in representation.[236]

150. techUK said employers who adopted more inclusive hiring practices would reap the benefits:

> […] businesses need to adopt more inclusive hiring practices including open recruitment—making sure recruitment practices are open and fair for all candidates, including those from different backgrounds—helping companies reach the widest possible pool of talent. It also means exploring the design of the advert and the looking at the process.[237]

151. Clare Viney, CRAC Chief Executive, also told us the STEM sector would benefit from greater guidance and dissemination of good practice.[238] Kemi Badenoch MP, the then Minister for Equalities, agreed that sustainable action from employers was critical,[239] but was cautious about setting diversity and inclusion-focused targets:

> You can use targets, but they often have unintended consequences. I would say that it is a little bit of everything: some education in letting people know what their options are is absolutely critical; and targets to make sure that companies do not ignore the problem, but targets that encourage them to game the system and do something weird is not resolving the problems that need to be solved and is not the intention.[240]

George Freeman MP, Minister for Science, Research and Innovation, also suggested that incentives would deliver greater benefits:

> In the end, the way to achieve [improved equality, diversity and inclusion] is to embed it, in my view, into both science and innovation through incentives, not through a top-down bureaucratic compliance process that is politicised. We need to let the data reveal what is going on and then incentivise that.[241]

152. **STEM-related roles are an important part of the UK labour market, and just as is the case in other workplaces, the benefits of improved diversity and inclusion are clear, for employers and employees alike. The path to achieving this is not necessarily STEM-specific, but is rather likely to require a concerted, long-term effort across the entire workforce.**

235 BCS, the Chartered Institute for IT (DIV0092)
236 National Engineering Policy Centre (DIV0088)
237 techUK (DIV0089)
238 Q21
239 Q422
240 Q423
241 Q462

153. ***In its response to this Report, the Government should detail how the newly-created Department for Science, Innovation and Technology intends to drive greater levels of diversity and inclusion across the UK's STEM sectors.***

Conclusions and recommendations

The nature and extent of under-representation

1. The Government should, in its response to this Report, tell us how it plans to monitor, evaluate and report on progress in delivering "in-house STEM capability" across public services, including the NHS and schools. (Paragraph 14)

2. The benefits of raising levels of diversity and inclusion in STEM education, research settings and workplaces were highlighted by many contributors to our inquiry. The Government, UKRI, other research funders, industry and the education sector have led and participated in many worthy inquiries, reports and initiatives. Yet progress has been limited at best. The status quo must not be accepted by those with the ability to drive change. It is not simply a legacy problem that will fade as society becomes more diverse. Action must be taken that truly moves the dial. The Government should make improving diversity and inclusion in STEM—and indeed in all aspects of society—a central part of its day-to-day activities and future agenda. It's not just good for business, it is fundamentally about being fair, and doing the right thing. The education and research sectors must follow the Government's lead and take a systemic approach to the challenge, making the STEM ecosystem in the UK a beacon of good practice when it comes to addressing under-representation. (Paragraph 32)

3. Improved data collection and the application of lessons from it are key to addressing under-representation. We welcome the biannual Research and Innovation workforce survey being led by BEIS, and the Government's recognition of the need to better capture the diversity challenge on the basis of characteristics other than gender—such as ethnicity, disability, sexuality, and socio-economic background. A survey can, however, only ever provide a snapshot, whilst concerted, targeted action would be better informed by a longitudinal study. The Government should set out how it plans to make the Research and Innovation workforce survey meaningfully useful across different departments, non-departmental bodies and the wider STEM sector. The forthcoming results must be accompanied by an action plan, and the survey should have the ability to undertake analysis by STEM occupation built in. (Paragraph 33)

STEM education in schools

4. All children should be able to see themselves in what they learn from an early age. The national curriculum and exam subject specifications should be kept under review and updated where it is appropriate to the context to include more diverse examples, such as female scientists. (Paragraph 38)

5. The careers advice and support pupils receive from the earliest years must promote diverse and inclusive role models. Just as it is desirable for children to see themselves in what they learn, they should also see themselves in who they aspire to emulate. The Government should consider how best to support schools and existing programmes, such as STEM Ambassadors, Speakers for Schools, and the Careers and Enterprise

Company, to ensure children access a diverse range of role models from research or industry. Careers advice guidance and support should also be regularly reviewed to ensure they reflect a full range of diverse examples. (Paragraph 44)

6. The data on STEM subject uptake and attainment at GCSE and A-level paints a complex picture. There are clear differences between boys and girls, with the latter seemingly less inclined to pursue STEM subjects than the former. The evidence our inquiry received offered no consensus as to the reasons for this difference—preference, consideration of future career prospects, and greater conservatism on the part of boys being suggested causes. (Paragraph 70)

7. The picture between and within different ethnic and socio-economic backgrounds is similarly complex, however, pupils from some backgrounds, such as Black Caribbean, are clearly underrepresented across STEM subjects at both GCSE and A-level. Others, such as pupils from Chinese backgrounds, are often well-represented. (Paragraph 71)

8. Access, or lack of it, to the separate study of biology, chemistry and physics at GCSE—known as the 'triple science' option—is a decisive factor for many pupils in determining whether they study STEM subjects at university and enter the STEM workforce. If the pool of students studying triple science lacks diversity, this will be reflected in STEM settings later in life. The Government should in its response to this Report tell us how it intends to ensure more pupils have access to triple science, or how else it proposes to overcome barriers to pursuing an interest in STEM faced by pupils from certain backgrounds. (Paragraph 72)

9. We welcome Ofsted's recent report examining science education in primary and secondary schools. However, some contributors to our inquiry suggested that given the importance of inspection, it could do more to encourage diversity and inclusion in STEM education. (Paragraph 76)

10. The Government should tell us whether it has consulted with Ofsted on levels of uptake and attainment among different groups of children, and whether it has discussed an expansion of its inspection criteria to include a more comprehensive picture of subject take-up and attainment across different disciplines and characteristics. (Paragraph 77)

11. Ofsted should, as part of its inspection criteria, gather data and report on levels of subject take-up and attainment among pupils with different characteristics, such as gender, ethnic background and socio-economic background. The latter could utilise Free School Meals eligibility, which is already used in Government education data. Where there are disparities, schools should record and be assessed against the steps they are taking to make subject take-up more representative. (Paragraph 78)

12. The Government should in its response to this Report set out how it intends to deliver on the Prime Minister's stated ambition. (Paragraph 88)

13. We recommend as an alternative to compulsion the introduction of a requirement for pupils who do not continue with a STEM subject post-16 to take the Advanced Mathematical Support Programme or a Core Science course. Core Science could be developed using the same applied principles as Core Maths and the Advanced Mathematical Support Programme. (Paragraph 89)

14. There are clear benefits when children are taught by teachers with qualifications, professional experience, or specialism in those subjects. The Government should set a target for every child to be taught STEM subjects by teachers with qualifications in that subject by the end of the decade. Teachers should be given access to improved, mandatory continuous professional development to ensure their knowledge remains up to date—which is particularly important in STEM subjects where there are new discoveries and developments on a regular basis. (Paragraph 96)

15. STEM teacher salaries must be as competitive as possible with the private sector, and we welcome the new STEM-focused bursaries and wider efforts by the Government to recruit and retain STEM teachers. However, we do not think the amounts currently on offer will prove anywhere near sufficient to address longstanding shortages, particularly in subjects such as computer science and physics. The fact that such a significant proportion of current university graduates in STEM subjects would be needed to address the shortfall underlines the scale of the challenge. (Paragraph 108)

16. The Government should assess the impact of further salary increases on recruitment targets for STEM subjects with particularly acute shortages; and detail its findings in its response to this Report. It should also tell us what further interventions are planned for subjects where recruitment targets are unlikely to be met, whether it has undertaken any assessment of the impact that increased numbers of STEM graduates from university courses would have of teaching workforce shortages, and whether it has any plans to grow the number of STEM graduates entering the teaching workforce. (Paragraph 109)

17. We welcome the Government's nationwide roll-out of a scheme with the engineering sector, designed to increase the number of Initial Teacher Training recruits with industry experience. The scheme should, subject to evaluation, be expanded to bring more STEM professionals into classrooms to help teach other subjects where there are shortages. (Paragraph 112)

18. The Government should consider what support it could offer to initiatives such as Now Teach, which draw upon experienced professionals to help meet STEM teacher recruitment challenges and to inspire a more diverse range of pupils to continue with STEM subjects. (Paragraph 113)

STEM research institutions

19. The Government, UK Research and Innovation and other research funders should make funding available for research facilities undertaking reasonable adjustments to ensure they are fully accessible. (Paragraph 127)

20. Some STEM researchers face a discriminatory working environment. Whilst this reflects inequities that exist elsewhere in society it is nevertheless a source of deep concern. The process of reducing and ultimately ending such prejudice will not be swift but is vitally important. (Paragraph 129)

21. Our inquiry received evidence that highlighted the importance of addressing as a matter of urgency the precarious nature of many contracts in STEM academia. We examined these issues in greater depth as part of our inquiry into reproducibility and research integrity. (Paragraph 132)

22. We welcome the move towards alternative processes such as narrative CVs and hope to see them become the norm in STEM research funding calls, subject to evaluation. (Paragraph 140)

23. UKRI must use the publication of its Equality, Diversity and Inclusion (EDI) strategy, and the multi-year funding settlement from Spring Budget 2022, as a launchpad to promote diversity and inclusion across the research sector. The final version of UKRI's EDI strategy must set out a timetable to implement processes to determine, monitor, publicly report against, and ultimately meet targets to reduce underrepresentation in funding awards and decision-making bodies, including its leadership and Research Council Committees panels/boards. (Paragraph 142)

24. Guidance to all Research Council staff should include a specific requirement to ensure representative Committees—for example, greater diversity could be achieved by appointing on potential, rather than on past achievements. (Paragraph 143)

25. STEM-related roles are an important part of the UK labour market, and just as is the case in other workplaces, the benefits of improved diversity and inclusion are clear, for employers and employees alike. The path to achieving this is not necessarily STEM-specific, but is rather likely to require a concerted, long-term effort across the entire workforce. (Paragraph 152)

26. In its response to this Report, the Government should detail how the newly-created Department for Science, Innovation and Technology intends to drive greater levels of diversity and inclusion across the UK's STEM sectors. (Paragraph 153)

Formal minutes

Wednesday 1 March 2023

Members present

Greg Clark, in the Chair

Aaron Bell

Tracey Crouch

Katherine Fletcher

Rebecca Long Bailey

Stephen Metcalfe

Graham Stringer

Draft Report (*Diversity and Inclusion in STEM*), proposed by the Chair, brought up and read.

Ordered, That the draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 153 read and agreed to.

Summary agreed to.

Resolved, That the Report be the Fifth Report of the Committee to the House.

Ordered, That the Chair make the Report to the House.

Ordered, That embargoed copies of the Report be made available, in accordance with the provisions of Standing Order No. 134.

Adjournment

Adjourned till Wednesday 8 March 2023 at 9.20am.

Witnesses

The following witnesses gave evidence. Transcripts can be viewed on the inquiry publications page of the Committee's website.

Wednesday 23 February 2022

Professor Jeremy Sanders CBE FRS, Chair, Diversity Committee, Royal Society; **Clare Viney**, CEO, Careers Research Advisory Centre-Vitae Q1–51

Katherine Mathieson, Chief Executive, British Science Association; **Dr Anna Zecharia**, Development Board Member, Equality, Diversity and Inclusion in Science and Health (EDIS) Q52–71

Dr Jake Anders, Deputy Director, UCL Centre for Education Policy and Equalising Opportunities; **Dr Rebecca Montacute**, Senior Research and Policy Manager, Sutton Trust Q72–103

Wednesday 16 March 2022

Professor Rachel Oliver FREng, Professor of Materials Science and representative, University of Cambridge and The Inclusion Group for Equity in Research and STEMM; **Professor Narender Ramnani**, Professor of Neuroscience, Royal Holloway University of London Q104–159

Sam Freedman, Senior Fellow, Institute for Government and Senior Adviser, Ark; **Russell Hobby**, CEO, Teach First; **Claudenia Williams**, Assistant Principal, Kingsley Academy Q160–196

Wednesday 27 April 2022

Katherine Sparkes MBE, CEO, Lightyear Foundation; **Dr Jasleen Jolly**, Associate Professor in Vision and Eye Research and representative, Anglia Ruskin University and National Association of Disabled Staff Networks; **Dr Gayle Brewer**, Senior Lecturer in Psychology and representative, University of Liverpool and National Association of Disabled Staff Networks Q197–208

Katharine Birbalsingh CBE, Chair, Social Mobility Commission, Headmistress, Michaela Community School Q209–226

Dr Izzy Jayasinghe, Senior Lecturer and UKRI Future Leader Fellow, and representative, School of Biosciences, University of Sheffield, and LGBTQ+ STEM; **Dr Katie Perry**, Chief Executive, The Daphne Jackson Trust Q227–251

Wednesday 18 May 2022

Dr Claire Crawford, Research Fellow, Institute for Fiscal Studies; **Professor Dame Athene Donald**, Master of Churchill College and Professor Emerita of Experimental Physics, University of Cambridge; **Dr Jasper Green**, Her Majesty's Inspector, Schools and Subject Lead, Science, Ofsted Curriculum Unit Q252–294

Clare Hayes, Deputy Head, Hyndland Secondary School; **Jane Lunnon**, Head, Alleyn's School; **Mark Turner**, Headteacher, Skipton High School for Girls Q295–338

Rachel Youngman, Deputy Chief Executive, Institute of Physics; **Professor Ulrike Tillmann**, President, London Mathematical Society Q339–362

Wednesday 15 June 2022

Mr Robin Walker MP, Minister for School Standards, Department for Education; **Paul Kett**, Director General, Skills, Department for Education	Q363–409
Kemi Badenoch, Minister of State for Equalities, Government Equalities Office; **Marcus Bell**, Director, Equality Hub; **Gillian Unsworth**, Head of Gender and Workplace Equality, Equality Hub	Q410–446
Professor Dame Ottoline Leyser DBE FRS, Chief Executive, UK Research and Innovation (UKRI); **George Freeman MP**, Minister for Science, Research and Innovation, Department for Business, Energy and Industrial Strategy	Q447–479

Published written evidence

The following written evidence was received and can be viewed on the inquiry publications page of the Committee's website.

DIV numbers are generated by the evidence processing system and so may not be complete.

1 Ada Lovelace Day (DIV0058)

2 Allsopp, Jane (DIV0107)

3 Ark Curriculum Plus (DIV0083)

4 Association of Medical Research Charities (AMRC) (DIV0100)

5 BCS The Chartered Institute for IT (DIV0092)

6 Bournemouth University (DIV0026)

7 British Heart Foundation (DIV0091)

8 British Neuroscience Association (DIV0051)

9 British Science Association (DIV0044)

10 British Society for Immunology (DIV0025)

11 Brunel University London (DIV0024)

12 CRAC/Vitae (DIV0102)

13 Campaign for Science and Engineering (DIV0010)

14 Cancer Research UK (DIV0098)

15 Centre for Analysis of Social Exclusion, LSE (DIV0014)

16 Chapman, Dr Emma (Royal Society Dorothy Hodgkin Fellow and Proleptic Lecturer, University of Nottingham) (DIV0004)

17 Chartered Institution of Highways & Transportation (DIV0019)

18 Christian Voice (DIV0034)

19 Cogent Skills (DIV0052)

20 Coventry University (DIV0055)

21 Department for Business, Energy and Industrial Strategy (DIV0047)

22 Donald, Professor Dame Athene (DIV0008)

23 Donald, Professor Dame Athene (Master of Churchill College and Professor Emerita of Experimental Physics, University of Cambridge) (DIV0111)

24 Engineering Construction Industry Training Board (ECITB) (DIV0077)

25 EngineeringUK (DIV0020)

26 Equality, Diversity and Inclusion in Science and Health (EDIS) (DIV0094)

27 Faculty of Engineering, University of Nottingham (DIV0046)

28 Fair Play for Women (DIV0007)

29 Founders4Schools (DIV0069)

30 Glaister, Professor Paul (Professor of Mathematics and Mathematics Education, University of Reading) (DIV0108)

31 Holford, Dr Angus (Research Fellow, University of Essex); and Leighton, Dr Margaret (Lecturer, University of St Andrews) (DIV0001)

32 IOE, UCL's Faculty of Education and Society (DIV0021)

33 Imperial College London (DIV0105)

34 Imperial College London (DIV0072)

35 Imperial College London (DIV0081)

36 In2scienceUK (DIV0080)

37 Institute of Physics (IOP) (DIV0033)

38 Jolly, Dr Jasleen (Clinical Academic, National Association for Disabled Staff Networks) (DIV0114)

39 Jones, Dr Stephen (Lecturer, University of Birmingham) (DIV0043)

40 Juliff, Louise (Team Leader (STEM Facilitation), Blaenau Gwent County Borough Council) (DIV0109)

41 King's Maths School (DIV0078)

42 Kiy, Robyn (PhD researcher, University of Liverpool); Afzal, Khoula (PhD researcher, University of Liverpool); and Shameem, Mahrukh (PhD researcher, University of Sheffield) (DIV0059)

43 Knowledge Exchange Unit, POST, UK Parliament (DIV0018)

44 Leake, Professor David (DIV0115)

45 LGBTQ+ STEM (DIV0110)

46 MBE, Derrick Willer (DIV0113)

47 MEI (DIV0038)

48 MESME (DIV0039)

49 Mathematical Institute and Department of Statistics, Oxford University (DIV0030)

50 Mathematical, Physical and Life Sciences Division, University of Oxford (DIV0063)

51 MathsWorldUK (DIV0016)

52 NRICH (DIV0005)

53 NUSTEM, Northumbria University (DIV0045)

54 National Association of Disabled Staff Networks (DIV0017)

55 National Engineering Policy Centre (NEPC) (DIV0088)

56 National Physical Laboratory (DIV0048)

57 Nuclear Skills Strategy Group (DIV0053)

58 Oliver, Professor Rachel FREng; Wade, Dr Jess BEM; Jayasinghe, Dr Izzy FRMS; Saini, Angela; and Pagel, Professor Christina (DIV0106)

59 One HealthTech (DIV0060)

60 Poskett, Dr James (Associate Professor in the History of Science and Technology, University of Warwick) (DIV0073)

61 Prospect (trade union) (DIV0031)

62 Protect Pure Maths (DIV0086)

63 Queen Mary University of London (DIV0099)

64 RSE Young Academy of Scotland (DIV0097)

65 Ramnani, Narender (Professor of Neuroscience, Royal Holloway University of London) (DIV0093)

66 Royal Aeronautical Society (RAeS) (DIV0040)

67 Royal Astronomical Society (DIV0035)

68 Royal Society of Chemistry (DIV0032)

69 Royal Statistical Society (RSS); The Institute of Mathematics and its Applications; and The London Mathematical Society Committee for Women and Diversity in Mathematics (DIV0087)

70 STEM Learning (DIV0076)

71 School of Life Sciences and Warwick Medical School, Faculty of Science, Engineering and Medicine, University of Warwick (DIV0067)

72 Science Museum Group (DIV0022)

73 Society for Applied Microbiology (DIV0028)

74 Sullivan, Professor Alice (Professor of Sociology, University College London) (DIV0049)

75 Tarafdar, Professor Monideepa (Principal Investigator of 'BIAS', Lancaster University); and Hu, Dr Yang (Co-Investigator of 'BIAS', Lancaster University) (DIV0095)

76 Teach First (DIV0037)

77 Techniquest (DIV0103)

78 The Academy of Medical Sciences (DIV0054)

79 The Alan Turing Institute (DIV0090)

80 The Blackett Lab Family C.I.C (DIV0075)

81 The Careers Research & Advisory Centre (CRAC) and Vitae (DIV0050)

82 The Daphne Jackson Trust (DIV0009)

83 The Francis Crick Institute (DIV0029)

84 The Inclusion Group for Equity in Research in STEMM (TIGERS) (DIV0071)

85 The Institution of Engineering and Technology (DIV0027)

86 The Met Office (DIV0057)

87 The Open University (DIV0036)

88 The Royal Society (DIV0104)

89 The Royal Society (DIV0015)

90 The Royal Society of Edinburgh (DIV0079)

91 The University of Manchester (DIV0011)

92 The University of Warwick (DIV0002)

93 UCL Centre for Education Policy and Equalising Opportunities (DIV0112)

94 UK BioIndustry Association (DIV0042)

95 UK Research and Innovation (UKRI) (DIV0084)

96 Universities UK (DIV0023)

97 University College London (UCL) (DIV0085)

98 University of Cambridge (DIV0041)

99 University of East Anglia (UEA) (DIV0082)

100 University of Essex (DIV0065)

101 University of Nottingham (DIV0061)

102 University of Reading (DIV0003)

103 Wellcome (DIV0096)

104 White, Dr Patrick (Associate Professor, University of Leicester); and Smith, Professor Emma (Professor of Education and Social Justice, University of Warwick) (DIV0056)

105 Yhnell, Dr Emma (Lecturer, Cardiff University) (DIV0070)

106 in, An Individual Working (DIV0101)

107 techUK (DIV0089)

List of Reports from the Committee during the current Parliament

All publications from the Committee are available on the publications page of the Committee's website.

Session 2022–23

Number	Title	Reference
1st	Pre-appointment hearing for the Executive Chair of Research England	HC 636
2nd	UK space strategy and UK satellite infrastructure	HC 100
3rd	My Science Inquiry	HC 618
4th	The role of Hydrogen in achieving Net Zero	HC 99

Session 2021–22

Number	Title	Reference
1st	Direct-to-consumer genomic testing	HC 94
2nd	Pre-appointment hearing for the Chair of UK Research and Innovation	HC 358
3rd	Coronavirus: lessons learned to date	HC 92

Session 2019–21

Number	Title	Reference
1st	The UK response to covid-19: use of scientific advice	HC 136
2nd	5G market diversification and wider lessons for critical and emerging technologies	HC 450
3rd	A new UK research funding agency	HC 778