CaSE
Campaign for Science and Engineering

Improving Diversity in STEM

A report by the Campaign for Science and Engineering (CaSE)

May 2014

Sponsored by

King's College London

www.sciencecampaign.org.uk

40,000 annual shortfall of STEM skilled workers

BME men are 28% less likely to work in STEM than White men

9% of those in non-medical STEM careers are women

ABOUT CASE

The Campaign for Science & Engineering (CaSE) is the leading independent advocate for science and engineering in the UK. CaSE works to ensure that science and engineering are high on the political agenda and that the UK has: world leading research and education; skilled scientists and engineers; and successful innovative businesses. Improving diversity in STEM is essential to achieving these aims.

CaSE is funded by individuals and organisational members from industry, learned societies, universities and research charities. For information on joining CaSE, please visit our website.

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INTRODUCTION

It is still the case that women, disabled people and those from ethnic-minorities or socially-disadvantaged groups are consistently underrepresented, particularly at senior levels, in science, technology, engineering and mathematics (STEM). Diversity issues also persist in other sectors, however, this report focuses on improving diversity in STEM due to the existence of STEM-specific barriers and challenges, and due to the significant benefits that improving diversity in STEM would bring for individuals and for the UK.

Since our 2008 report, Delivering Diversity, much has been written and recommended to address the lack of diversity in STEM, but diversity is disappointingly far from being 'delivered'. What has changed is that diversity is high on the political agenda and this report puts forward ways that this political will can be converted into meaningful action. This report brings together data and research to build a picture of the current state of diversity in STEM, from education to the workforce. There has been some concerted effort in pockets of the sector since 2008, but this now needs to become the norm if we're to see widespread change.

This report recommends tangible actions for the Government and the sector to take. Some strong themes emerge, including the need for:

- Government to show leadership in tackling diversity
- A fully equipped and diverse teaching workforce
- Better reporting and public monitoring of diversity data.

There is a detailed list of actions at the end of each section.

8% of British engineers and 4% of engineering apprentices are women

1 out of 7 Research Councils have ever had a female CEO

60-70% proposed cuts to support for disabled students

63% cut in funding for diversity from BIS since 2010

ACTIONS: QUICK WINS AND BIG WINS

'QUICK' WINS

Make unconscious bias training mandatory for all members of grant awarding boards and panels across all 7 Research Councils.
Department for Business Innovation and Skills and Research Councils

Halt the announced changes to the Disabled Students' Allowance and instead removes caps on financial support bringing it in line with employment support.
Department for Business Innovation and Skills, HEFCE

Urgently review and amend the National Careers Service website with input from STEM careers specialists.
Skills Funding Agency

'BIG' WINS

Make diversity a central consideration in the development and implementation of all government policy making for STEM, including apprenticeships, teacher training, university funding, curriculum reform and careers advice.
Department for Education, Department for Business Innovation and Skills, Ofqual

Proactively engage with the Equality Challenge Unit's Race Equality Charter Mark to uncover and address barriers to access, progression and success for staff and students.
Universities

Appoint and train a science subject leader in every English primary school by the end of the next term of Government.
Department for Education, Schools

52 percentage point gap between state and selective school single science uptake

40% Postgraduate research students are self-funded

0 mentions of diversity in Richard Review on apprenticeships

Disabled STEM students 57% less likely to take up postgraduate STEM study than non-disabled students

> It has been a pleasure to partner with King's College London on this important project. I am grateful for their support in sponsoring the production of this CaSE report and hosting our Opinion Forum on diversity in science and engineering. Here, Professor Evelyn Welch, Vice Principal Arts & Sciences, provides her perspective.

Dr Sarah Main, CaSE Director

A MESSAGE FROM OUR SPONSOR

"I was delighted that King's was able to host the CaSE's Opinion Forum on improving diversity in STEM. The discussion was forward looking and has significantly informed the development of the key actions in this important, ambitious and timely report.

This report makes a compelling case for diversity and a practical road map for achieving transformative improvements to inform the future actions and attitudes of policy makers, employers, schools, colleges and universities, and professional bodies.

We've made some progress in the last decade in diversifying the student base and academic staff workforce career progression in higher education, but there are still a challenging range of underlying structural and cultural barriers to address.

The advent and growing impact of the Athena SWAN charter has been really positive. At King's, there is growing demand for approaches originally developed for specific departments or schools under the auspices of Athena SWAN to be applied in other STEM and non-STEM schools, and we are proud to be piloting the Gender Equality Mark in our department of Social Science, Health & Medicine.

As we go forward we need an even more intensive focus, across the STEM community, on collaboration and rigorous evaluation of what works. We also need to be ambitious in seeking to learn from other countries, as well as non-STEM sectors in the UK labour market and education sphere, when it comes to advancing diversity.

From systemising unconscious bias training, to flexible working and developing parental leave and childcare funds, real benefits will flow from universities working ever more closely with one another and with organisations such as CaSE.

Finally, I strongly endorse one of the central arguments CaSE has – rightly – sought to make in this report, which is that improving diversity in STEM isn't an optional extra. While there are strong arguments on the grounds of fairness and equality of opportunity, there is an economic competitiveness imperative at the heart of this agenda.

We need to fully tap and develop the talents of all segments of the population if we are to be truly successful in the Sciences on a global scale. I am delighted that King's has been able to provide its support for this important initiative."

Professor Evelyn Welch, Vice Principal Arts & Sciences, King's College London

1) DIVERSITY: THE BIG PICTURE

A more diverse science, technology, engineering and mathematics (STEM) workforce is not simply desirable in terms of equality, but necessary if we are to maximise individual opportunity and meet economic need.

Studying STEM subjects at school, college or university opens doors to a huge range of careers, many of which do not yet exist. Scientists and engineers work all over the world, from the bottom of the ocean to the moon and everywhere in between. There isn't a typical 'STEM job' and yet there is a persistent 'STEM stereotype' that is learned at a young age[1], mirrored in STEM workforce demographics, and which needs to be deconstructed[2]. Increasing the diversity of those choosing to study or begin working in STEM is only part of the challenge; there is still change required to ensure that STEM working environments are inclusive and places where individuals have an equal opportunity to participate and advance[3].

In 2013 David Cameron stated that "if we are going to succeed as a country then we need to train more scientists and more engineers"[4]. There are estimates that the UK has an annual shortfall in domestic supply of around 40,000 new STEM skilled workers[5] and we need to double the number of graduates and apprentices in the engineering discipline alone by 2020 to meet demand[6]. Meeting this challenge will simply not be possible without improving diversity in STEM.

There have been many government reviews focused on STEM skills, due to their importance to the UK, with some making the link between the skills shortage and a lack of diversity. Unfortunately many of these remain pertinent a decade on. Much of the content of the Roberts Review[7] from 2002 and the Sainsbury Review of 2007[8], particularly in relation to diversity in STEM, still applies today. In 2004 the Government's ten year Science and Innovation Investment Framework[9] stated the need for a "step change" in the proportion of minority-ethnic and women participants taking STEM subjects in higher education.

In the same year, the STEM Mapping Review[10] highlighted that there was a plethora of initiatives to boost overall STEM participation but judged there was inadequate coordination and evaluation of what works. Furthermore it stated that there was a policy gap; a lack of initiatives encouraging women, girls and ethnic minorities into STEM. Thankfully this last point could not be said of the landscape in 2014.

This report shows that there has been a great deal of interest and activity seeking to increase diversity in STEM education and employment. However, as in 2004, there is inadequate coordination and evaluation of what works. Much has changed, but we are still seeking, and the economy still needs,

a step change in equality and diversity in STEM. Existing effective activities need to be better funded, better supported at every level, and be coordinated and communicated more widely. There also needs to be a genuine desire to effect change to ensure that in five years' time we've made the long-awaited 'step change' in diversity in STEM.

2) THE CASE FOR DIVERSITY

There is a strong case for working towards a more diverse STEM workforce. On the basis of equality alone, any barriers to individuals, or groups, entering and succeeding in the STEM workforce should be removed. Improving diversity in STEM also has the potential to benefit businesses, maximise individual opportunity, and meet a national economic need.

Evidence points to the benefits of increasing the level and depth of STEM skills in the workforce[11,12]. There are numerous reports pointing to a significant shortfall in STEM skilled workers and increasing demand for STEM skills in future, from technician level upwards[13,14,15]. One way to close the gap between supply and demand is to improve the participation, retention and success in STEM study, training and employment from amongst populations currently underrepresented. In the UK, and across the world, STEM skilled workers are in demand from companies in a range of sectors meaning there are relatively high returns and good job security for STEM skilled individuals. On average those working in STEM occupations earn 20% more than those working in other fields[16]. In addition to the premium attached to a degree[17], STEM graduates typically earn higher wages than non-STEM graduates[18,19]. Unfortunately the evidence suggests that these opportunities are not equally accessible to all.

There is also evidence highlighting a strong business case for companies having a diverse workforce and culture that supports diversity and inclusion. Studies suggest that organisations that deliver on diversity perform better financially, recruit from a wider talent pool, reduce staff turnover and increase creativity and problem solving capability[20,21,22].

3) OVERARCHING ISSUES

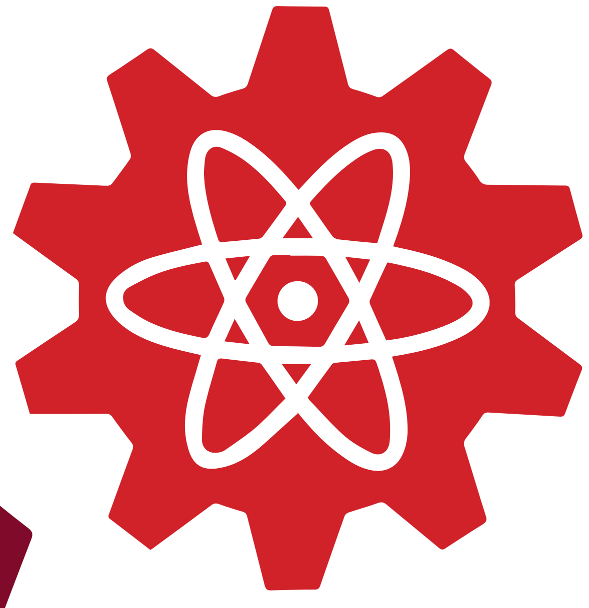
PIPELINE

In recent years there has been some rethinking over the STEM pipeline model, which describes the linear sequence of steps necessary to become a scientist or engineer[23]. The link between studying a STEM subject and working in a STEM job has been an important part of the Government's STEM skills strategy[24]. This view is changing, with leaks in the pipeline no longer being considered as necessarily negative, recognising that it is beneficial to the economy as a whole to have those with STEM skills working in other sectors[25]. However, it is still the case that leaks are unevenly distributed across different groups[26]. Where the move out of STEM has not been through choice (i.e. individuals would have wanted to stay on in STEM careers but instead are in alternative usually lower-skill, lower-paid work), there remains cause for investigation, concern and action. For instance the diversity of the academic workforce significantly narrows from senior academic to professor level. CaSE, therefore, supports the recommendation in the House of Commons Select Committee report on Women in Scientific Careers[27] that Higher Education Institutions (HEIs) should routinely conduct exit interviews with all academic staff leaving employment. If this information is collected and collated in a consistent manner, is publicly available and disaggregated by diversity characteristics, it will provide a helpful evidence base on which future policy decisions at department, university and government level can be made. Different issues and actions for particular groups will be discussed later in the report.

TEACHING AND DIVERSITY

Teachers have an important role to play in delivering diversity. Two key factors are the diversity of the teaching workforce itself and whether teachers are trained and equipped to teach diverse groups of students, aware of the learning needs of different groups of students and any potential bias within their teaching. CaSE's 2008 Delivering Diversity report[28] touched on the importance of both. These factors are as important and potentially under greater threat than in 2008.

At that time the Training and Development Agency for Schools (TDA) had funding for and were working towards a more diverse teaching workforce. In 2010 that funding and the recruitment targets were removed, and in 2012 the TDA was closed. In 2013 the National College for Teaching and Leadership, an executive agency of the Department for Education, was formed with the remit of improving the quality of the teaching workforce; and helping schools to help each other to improve[29]. Other significant changes to the landscape since 2008 include the introduction of School Direct[30], and the introduction of Academy Schools which can recruit teachers who do not have qualified teacher status (QTS)[31].



Teacher training plays an important role in equipping teachers for professional practice more broadly but also in how to recognise and eliminate bias in their own practices[32,33]. The growing proportion of schools now able to recruit teachers without QTS is therefore a concern. All teachers, through initial teacher training and continuing professional development (CPD) should be equipped to teach a diverse range of students. This training should explore issues around unconscious bias and addressing stereotypes, including STEM stereotypes, from primary level upwards.

It is still the case that most children will never be taught by a teacher from an ethnic minority. In 2013/14, the percentage of trainee teachers from ethnic minorities remains unchanged from 2006/07 at 12%[34]. However, the headline figure masks differences between training routes. For example, 12% of trainees in provider-led[i] training are from ethnic minorities. In Schools Direct fee and salary routes this figure drops to 9% and 10% respectively[35]. Provider led training currently accounts for the majority of training places but will see a further 15% reduction for 2014-15 whereas School Direct places are to increase by 61%, from 9,586 to 15,400[36]. As the number of teacher training places for School Direct is increased, the diversity of teachers should be carefully monitored by the National College of Teaching and Learning, and action taken to ensure the diversity of teacher intake, across a range of factors, is not only maintained, but increased.

[i] Provider-led training refers to initial teacher training led by a teacher training provider such as a university or college, rather than by a school as is the case in Schools Direct.

> Only 6,000 science specialists were distributed over 17,000 maintained primary schools in England

Research has shown the strong impact that primary teachers' knowledge and confidence in science have on students' attitudes towards science and their attainment and progression in it[37]. Data from 2009 found that only 6,000 science specialists were distributed over 17,000 maintained primary schools in England[38]. Currently around 5% of teachers in primary education have a science related degree[39]. Due to the scale of the gap, while seeking to increase the number of science graduates training as primary school teachers, it is essential that teachers without existing science specialism are trained as science subject leaders. It should be an expectation that by the end of the next term of Government, every English primary school appoints a science subject leader who would be expected to remain up to date with appropriate subject specific CPD specifically designed for this purpose[40]. The government could support this increase in primary science expertise by investing in the professional development of existing primary teachers (at a cost of £2 million per annum)[ii] to ensure that every child has access to a high-quality science education.

CAREERS EDUCATION, INFORMATION, ADVICE AND GUIDANCE (CEIAG)

Arguably there has never been a golden age of careers advice. In 2007 The Sainsbury Review spoke of the need for better awareness of the careers STEM study opens up and of the need for better STEM careers education as part of the curriculum, supported by CPD for teachers[41]. Since 2007 concern about CEIAG in schools has only increased.

Since 2012 schools in England have been legally responsible for arranging independent, impartial careers advice and this is now for pupils in years 8 to 13. At the same time the compulsory inclusion of careers education in the school curriculum has been removed. These are significant changes in the careers landscape and there is continued concern that CEIAG falls short of the level needed to ensure young people are able to make informed choices about their future. Indeed Ofsted recently reported that three quarters of the schools they visited were not implementing their duty to provide impartial careers advice effectively[42]. CaSE calls for the Government to rethink its policy on careers. Any shortfalls in CEIAG will be particularly damaging for young people from less advantaged backgrounds[iii] and will leave current trends and biases around participation in STEM unchallenged. In addition to careers advice, broad careers education to increase young people's knowledge of and access to the range different possible careers, including those in STEM, should be a requirement in schools from primary level upwards.

Research shows that young people have high academic and career ambitions. However, they are constrained by gender, disability, and ethnicity and by economic and social background and circumstances[43]. Evidence suggests that shortages in the number of young people pursuing STEM are not, for the most part, due to negative attitudes towards science. STEM-related careers are often narrowly perceived, with students and their advisors unaware of the transferability of STEM skills, and the range of careers that continuing in STEM can open up. Furthermore there is evidence to suggest that the careers advice young people receive often serves to perpetuate unhelpful stereotypes[44,45].

These issues are particularly acute for children from families with a low level of 'science capital' (i.e. qualifications, knowledge, and connections with science)[46]. BIS recently surveyed parents and their 11-14 year old children on choices around engineering. In line with the science capital argument, the most common responses to why the parents or children surveyed did not consider engineering as a career choice were that they didn't know anything about engineering, didn't know any engineers or just hadn't considered it[47]. This highlights the potential benefits that including parents or families as key audiences in careers interventions could bring[48]. As part of their careers work, schools should look for opportunities to engage with the families of their students, particularly those from more socially disadvantaged backgrounds, to increase science capital and more broadly to increase awareness of the wide variety of careers that are opened up through mathematics and science study[49].

There is evidence suggesting that 'one-off' interventions on their own have little long-term or widespread impact on science choices and participation rates, instead there is evidence to suggest the value of more sustained activity to integrate science careers awareness into the mainstream science curriculum[50,51]. All teachers should be supported in integrating science careers awareness as part of teaching and learning by including training on careers education within initial teacher training and subject-specific or other CPD for teachers.

Since 2008 there have been a number of initiatives to increase access to more visible role models in STEM. The Science Council have released a list of 100 leading UK practicing scientists in an attempt to challenge the current narrow view of science careers and scientists[52]. There are a variety of other examples including mentoring or ambassador programmes and web resources from STEMNET, WiSET, STEM Disability Committee, Science Grrrl[53], the Royal Academy of Engineering[54], the Royal Society of Chemistry, the Royal Society and others.

There are a plethora of STEM careers resources online[55,56] such as Future morph, Tomorrow's Engineers, Maths Careers, Talent 2030, the National STEM centre careers project[57] and the STEM Subject Choice and Careers Project campaign[58] developed as part of the 2004-2014 national strategy. As in the 2007 Sainsbury Review, the broad message is that that a decision to study STEM subjects leads to a wide range of interesting and well-paid jobs, both inside and outside the STEM arena[59]. This is a prime area where there could be great benefit from more joined up thinking, funding and working.

The Gatsby Foundation report, Good Career Guidance, looks at career guidance in secondary schools and how it could be made better. It proposes eight benchmarks that could be used to highlight and measure 'what good careers guidance looks like' and it would be extremely valuable if implemented in schools nationally, at a cost of less than 1% of a school's budget according to the report[60]. This would move the longstanding debate about CEIAG in schools on and give schools a framework for action. In relation to STEM specifically, the Government's flagship National

[ii] Estimate from the Wellcome Trust

[iii] See social disadvantage section for further discussion on this issue

Careers Service (NCS) website has outdated information, is not fit for purpose and does not reflect Government priorities, young people's needs or the needs of those looking to retrain. The content and emphasis of the National Careers Service website should be urgently reviewed and amended with opportunities for input from STEM careers specialists, particularly on the young people page and the content relating to STEM. Considering the opportunities STEM opens up for future careers there should be clear, engaging and accurate information on pathways, clarity around the different opportunities STEM study can lead to with diversity issues taken into account throughout the design and content of the site. Channels for STEM organisations to easily feed in should be developed to ensure that the service makes use of the wealth of STEM careers resources and expertise available.

WORK-LIFE BALANCE

The current government have taken some steps to make employment practices in the UK more flexible and family-friendly[61]. Technological advances are also playing a role in opening up more options for flexible working in many jobs[62]. There are many reports that outline the business case for flexible working[63,64]. For employers it can bring increases to productivity, access to a wider talent pool and improved staff retention. For employees it brings better work life balance, including being better able to manage caring responsibilities.

> "The careers advice young people receive often serves to perpetuate unhelpful stereotypes"

There are plans to change the law to extend the right to ask for more flexible working arrangements to all employees. Across all sectors in the UK around 96% of employers offer some form of flexible working. Three-quarters of employees make use of some form of flexible working, with a third (32%) reporting they work part-time – the most commonly used flexible working option. A quarter of employees use some sort of flexitime and 20% work from home on a regular basis[65].

While women are significantly more likely to take a career break than men[66], support may be required by both genders for a variety of reasons, from ill-health to caring for sick relatives. CaSE believes a change in culture is required within the workforce to remove any stigma surrounding flexible working and to ensure that those working part time or returning from a career break at every level within organisations are adequately supported and in no way penalised for their choices. Particularly in academia the prevalence of short term contracts is also a major issue for early career researchers in particular. CaSE supports the Science and Technology Committee's recommendation[67] for Government to work with the Higher Education sector to review the academic career structure and increase the number of more stable and permanent post-doc positions.

Returner schemes such as those run by the Daphne Jackson Trust, the Wellcome Trust[68], and some universities support researchers who wish to return to science after a career break[69,70,71]. CaSE believes greater work needs to be done to increase the scope of these schemes and raise awareness of them. Government should commit to increase support for the Daphne Jackson Trust to ensure they are sufficiently funded to extend and develop their fellowship model to include those returning to professional engineering, enabling them to support more people returning to work after a career break.

In our 2008 report we called for action to ensure that the Research Excellence Framework (REF) must include a mechanism that does not penalise part-time workers or those returning to work after a career break[72]. It is encouraging to see the REF criteria take this into consideration by allowing eligible researchers to submit a reduced number of outputs[73]. It will be important to review the suitability of the criteria used in the current round of REF to ensure that there is no penalty for departments successfully promoting inclusive working and policies. This is essential both in terms of encouraging good practice but also as it would otherwise run in conflict with other government funding dedicated to increasing diversity in STEM.

DIVERSITY AND GOVERNMENT

Science policy, skills policy, equalities policy and education policy all have implications for diversity in STEM. Since 2008 there have been some examples of integrating diversity in government policy as CaSE called for in Delivering Diversity in 2008. This can be seen in the linking of funding for some research[74] and capital[75] for STEM with measures of, or commitments to, gender diversity. This is a welcome step forward. However, there are also examples of significant missed opportunities. The recent Richard Review of apprenticeships is silent on all aspects of diversity and makes no reference to the Peter Little Review from 2012. Although the Government's response states that it will measure how the impact of the reforms varies by factors such disability or gender of apprentices, it is evident that diversity is being treated as a side-issue in relation to the expansion and reform of apprenticeships and not as a central factor in policy decisions. When considered across the piece, diversity is still treated as a side-issue in STEM policy to be dealt with in isolation. Diversity needs to be integrated throughout government policy making for STEM if we are to see real change.

> "Science policy, skills policy, equalities policy and education policy all have implications for diversity in STEM"

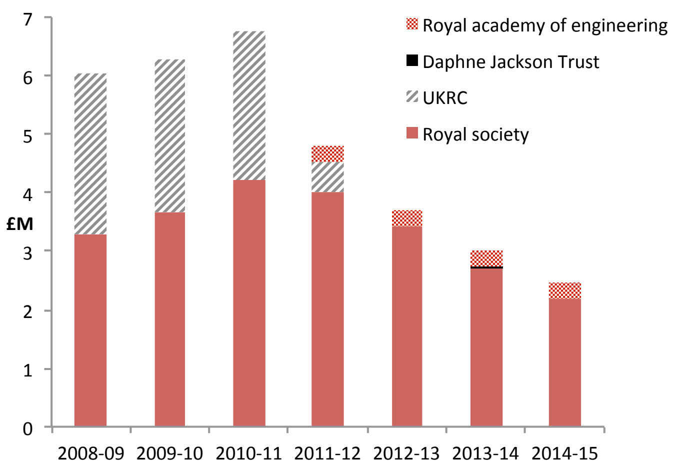
As part of their commitment to diversity the Government should be taking the lead on the diversity agenda working to ensure that there are no intrinsic barriers to under-represented groups progressing into and within Government and linked public bodies, particularly those associated with STEM where there is not a strong history of diversity in leadership. For example, six out of the seven current Research Council Chief Executives are male[76] and only BBSRC has ever had a female in the role. More widely, of the 96 public appointments BIS ministers made in 2012/13 77% are male, 96% white and none have a declared disability[77]. There is a target that half of public appointments across government are female, however, total government figures can mask the issues in STEM areas. The Government have worked with FTSE100 companies to improve the diversity of company boards through targets and voluntary commitment to a code. The Secretary of State for Business, Innovation and Skills has stated that continued pressure on FTSE100 companies and recruiters is needed and has supported the idea of all-women shortlists[78]. The Office of the Commissioner for Public Appointments (OPCA) code is designed with supporting diversity in mind. However, considering the imbalanced starting point, Government should take the lead and commit to action. A proactive approach should be taken, including the setting of goals, for the public appointments for which the Department for Business, Innovation and Skills is responsible. For instance, CaSE would welcome the taking forward of the recommendation from the Royal Society of Edinburgh's report, 'Tapping all our talents', that when employing head-hunters to fill vacancies for senior positions, the UK Government should ensure that the head-hunters offer up an equal number of suitably qualified male and female candidates[79]. Further, CaSE would like to see BIS commit to ensuring that the long-list of candidates for any BIS public appointment is not all-white or all-male.

It is encouraging to see the Government coordinating a new compact seeking to work in partnership to solve the underrepresentation of girls and women in technology and engineering, along with a campaign to raise the proportion of pupils, and girls in particular, taking physics and mathematics A-levels.

FUNDING DIVERSITY

From 2004 there was government funding for the UK resource centre (UKRC) for women in SET. This showed a clear commitment by the Government to studying the barriers that women face in science and supporting them over such hurdles. However in 2010 funding for the UKRC was abolished - a great blow for gender equality in STEM. The Government reasoning behind the removal of public funding to UKRC was that having it as a separate entity was wasteful. However, the Government has only allocated around 8% of the funding formerly available for the UKRC to support diversity work. In particular it now funds a diversity programme that is a joint collaboration between the Royal Academy of Engineering and the Royal Society[80]. The UKRC has been incorporated as part of WISE but due to dramatically lower levels of resource, much of the work formerly done by UKRC is no longer undertaken[81].

Figure 1 –
Diversity funding from BIS 2008-2015[82]



As Figure 1 shows, the funding from BIS for diversity has more than halved (63% cut) in real terms since 2010-11 from £6.8m to £2.5m in 2014-15. The reason given for the removal of funding for the UKRC has been that "there was a view that some of the work could be done by the Royal Society or the Royal Academy of Engineering and more mainstreamed"[83]. However, their funding for diversity has also been nearly halved since 2010-11. CaSE calls for BIS to monitor the effect of the reduction in its STEM diversity funding on the retention and progression of women in STEM and the ability to measure progress. If a detrimental effect is found, BIS should look to direct funding towards existing initiatives that have proven effective at increasing diversity in STEM.

In particular, the removal of funding has reduced the availability of comprehensive data series on diversity to which the sector has easy access. Formerly the UKRC produced annual data reports on different aspects of gender equality in STEM within academia. This helpful resource for consistently monitoring and analysing the landscape is no longer available. The Equality Challenge Unit (ECU), Science Council Workforce data and Royal Society and Royal Academy of Engineering amongst others are helpful sources of information. However, without a comprehensive view of diversity across STEM it is difficult to measure progress. Much diversity data is still collected and CaSE recommends that BIS takes responsibility to reinstating and funding an annual analysis which is broadened to include aspects of diversity beyond gender to ensure comparable and consistent monitoring of progress.

ACTIONS: OVERARCHING ISSUES

Higher Education Institutions (HEIs) should routinely conduct exit interviews with all academic staff leaving employment

All teachers, through initial teacher training and continuing professional development (CPD) should be equipped to teach a diverse range of students. This training should explore issues around unconscious bias and addressing stereotypes, including STEM stereotypes, from primary level upwards

As the number of teacher training places for School Direct is increased, the diversity of teachers should be carefully monitored by the National College of Teaching and Learning, and action taken to ensure the diversity of teacher intake, across a range of factors, is not only maintained, but increased

It should be an expectation that by the end of the next term of Government, every English primary school appoints a science subject leader who would be expected to remain up to date with appropriate subject specific CPD specifically designed for this purpose

In addition to careers advice, broad careers education to increase young people's knowledge of and access to the range different possible careers, including those in STEM, should be a requirement in schools from primary level upwards

As part of their careers work, schools should look for opportunities to engage with the families of their students, particularly those from more socially disadvantaged backgrounds, to increase science capital and more broadly to increase awareness of the wide variety of careers that are opened up through mathematics and science study

All teachers should be supported in integrating science careers awareness as part of teaching and learning by including training on careers education within initial teacher training and subject-specific or other CPD for teachers

The content and emphasis of the National Careers Service website should be urgently reviewed and amended with opportunities for input from STEM careers specialists, particularly on the young people page and the content relating to STEM

CaSE supports the Science and Technology Committee's recommendation67 for Government to work with the Higher Education sector to review the academic career structure and increase the number of more stable and permanent post-doc positions

Government should commit to increase support for the Daphne Jackson Trust to ensure they are sufficiently funded to extend and develop their fellowship model to include those returning to professional engineering, enabling them to support more people returning to work after a career break

It will be important to review the suitability of the criteria used in the current round of REF to ensure that there is no penalty for departments successfully promoting inclusive working and policies

Diversity needs to be integrated throughout government policy making for STEM if we are to see real change

the Government should be taking the lead on the diversity agenda working to ensure that there are no intrinsic barriers to under-represented groups progressing into and within Government and linked public bodies, particularly those associated with STEM

A proactive approach should be taken, including the setting of goals, for the public appointments for which the Department for Business, Innovation and Skills is responsible

CaSE calls for BIS to monitor the effect of the reduction in its STEM diversity funding on the retention and progression of women in STEM and the ability to measure progress. If a detrimental effect is found, BIS should look to direct funding towards existing initiatives that have proven effective at increasing diversity in STEM

Much diversity data is still collected and CaSE recommends that BIS takes responsibility to reinstating and funding an annual analysis which is broadened to include aspects of diversity beyond gender to ensure comparable and consistent monitoring of progress

4) DISABILITY AND STEM

According to the Equality Act (2010), "a person has a disability if he or she has a physical or mental impairment and the impairment has a substantial and long-term adverse effect on his or her ability to carry out normal day-to-day activities"[84]. It is unlawful to discriminate against disabled people, and employers, universities and other education providers must provide reasonable adjustments to facilitate access for all disabled employees and students[85]. This is of particular significance for challenging situations, such as laboratory settings, where such adjustments could be financially and practically difficult, but possible as shown by the work that has been done so far to work towards making science accessible for all[86,87].

STEPS FORWARD

Since 2008 there have been some noticeable steps forward, particularly around resources for and focus on disabled students and employees in STEM. In particular the establishment of the STEM Disability Committee in 2011[88], following recommendations from CaSE in the 2008 Delivering Diversity report, is encouraging. The committee explores practical ways to improve policies, practices and provision for disabled people. For example, the Committee, in collaboration with the Scottish Sensory Centre, has developed over 300 physics and engineering terms in British Sign Language aiming to remove barriers to deaf people fully participating in science[89,90]. They have created a resource for supporting STEM students with dyslexia[91], the website signposts to resources[92] for disabled people and their employers or educators, and they held a conference in 2013 bringing together those working in academia to identify practical solutions to barriers faced by disabled students specifically studying for STEM careers. Through promoting good practice, signposting to resources and by undertaking and coordinating further research and projects this committee will contribute to advancing progress in provision for disabled students and employees in STEM areas.

DISABILITY AND EMPLOYMENT

In 2010/11 there were 5.2 million disabled adults of working age in the UK (Figure 2)[93]. Working age disabled people are also almost half as likely to hold a degree-level qualification as those without a disability[94]. Disabled people have consistently been significantly less likely to be in high-level employment compared to non-disabled people[95] and just under half (49%) of working age disabled people are in employment[96]. Disabled people are more than twice as likely to report working part time as working full time. These proportions have varied very little in the last six years. In some cases this may be explained by reasons linked to specific disabilities, however there is still much than can be done to break down artificial barriers to disabled people participating and excelling in education and the workforce. Disabled people are less likely to work in STEM occupations than their counterparts without disabilities (Figure 3). Some, but not all, of this difference can be linked to lower overall employment rates for disabled people[97].

Figure 2 –
Percentage disabled students and percentage disabled working age adults
Source: HESA and ODI

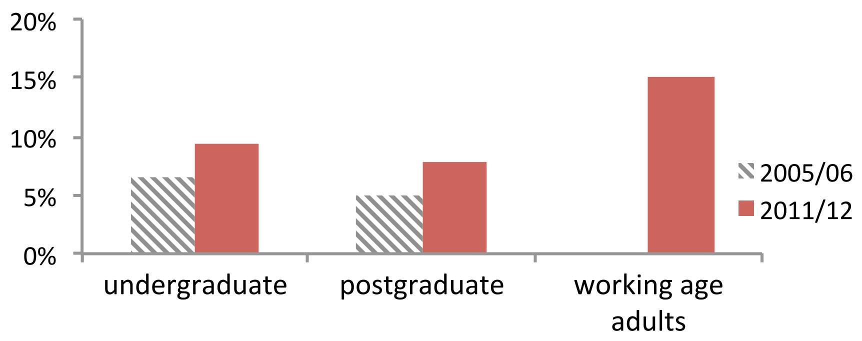
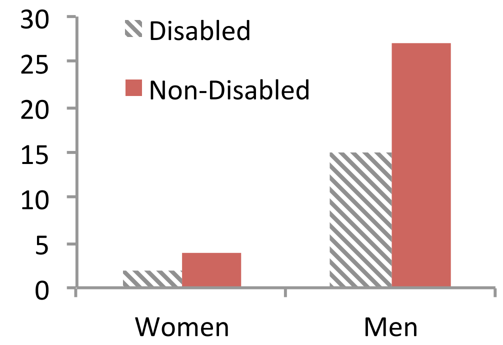


Figure 3 –
Percentage of the working age population employed in STEM occupation varies by disability status and gender[98]



DISABILITY AND APPRENTICESHIPS

Apprenticeships in STEM fields can offer great employment and progression routes. Schemes such as Deaf Apprentice run by Positive Signs, helps employers to offer inclusive apprenticeships and practical support to deaf applicants[99]. In 2012 Peter Little published his review looking at how to create a more inclusive Apprenticeship offer for people with learning difficulties and disabilities. The subsequent government action plan was encouraging, outlining how they would take forward recommendations[100]. However as discussed earlier, the recent Richard Review[101] informing apprenticeship policy does not make reference to the Little Review or consider diversity issues at all. The government should return to the Peter Little review and include its recommendations on disability in guidance and requirements to employers and training providers looking to access funding for apprenticeships.

DISABILITY AND HIGHER EDUCATION

Employment outcomes for disabled graduates show 59% are in employment within six months of graduating and eight percent continue to further study[102]. University study is of course not the only route into high-level employment, however, as graduates are more likely to be resilient in the labour market it remains important to remove any barriers to those with disabilities taking up and completing a degree. CaSE calls for a drive to improve awareness for school leavers and their advisors of the support available for disabled students wishing to pursue higher education STEM courses.

Attainment at school is one factor that contributes to progressing to further study post-18 and to good labour market outcomes. Another key consideration is the substantial disparities in employment outcomes between disabilities. For example, the employment rates for disabled people with depression or anxiety and those with severe or specific learning disabilities have been significantly lower than the employment rates for disabled people with most other types of impairment[103].

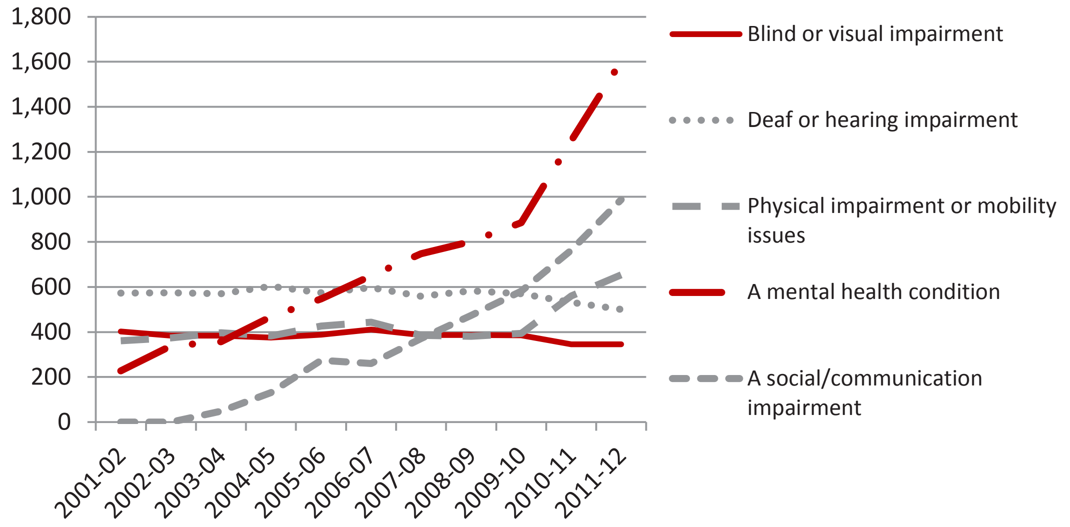
Higher Education Institutions have been in receipt of funding specifically to help with costs of improving their provision and support for disabled students since 2001 and there has been significant progress made in the sector, but more can still be done[104]. For those who choose to go on to university, those with some form of 'specific learning difficulties' account for the majority of the increases in numbers of disabled students[iv] across all levels and subjects of study from 2007/08 to 20011/12[105]. Over the last decade, the number of undergraduates with a declared mental health condition or a social/communication impairment studying STEM subjects has significantly increased, as shown in figure 4[v]. There is a similar picture when looking at the sector as a whole. It is difficult to say whether this is due to increased access to university for students with these disabilities or due to increased diagnosis and declaration of disability. Both would be encouraging. Interestingly figure 4 also shows an above trend increase of 70% in the two years since 2009/10 in undergraduate STEM students with physical impairment or mobility issues. For all subjects the increase was 80%. Going forward it will be important to measure how the increase in diagnosis and declaration of disability and/or access to university translates into outcomes, including access to further study and employment.

The Disabled Student's Allowance (DSA) has been one of the higher education diversity success stories. Disabled students have been able to apply for financial support from the Government to provide the additional support they need to study and can be linked to improved retention and success for disabled students. This is particularly apparent for mature students where discontinuation rate is 11% compared to 18% for disabled mature students not in receipt of DSA[106]. However, the government have announced changes to the DSA that will come in in 2015-16.

[iv] Those whose disability status is either "Receive DSA" or "Declared a disability, do not receive DSA"

[v] Students declared as having a "specific learning difficulty" or "other disabilities" have not been included in figure 4 due to issues of scale with 61,495 and 25,087 students respectively in 2011-12.

Figure 4 –
Number of undergraduate STEM students with specific disabilities



Source: HEFCE analysis of HESA data

They have been estimated to equate to 60-70% cuts[107] with the burden of support being squarely put onto universities[108]. There may be cause for some 'modernisation' of the DSA to reflect changes such as the now widespread ownership of laptops, compared to when the DSA was designed. However, the changes go much further and have been announced prior to an equality analysis despite the potential to deliver a serious blow for disabled students. One of the most worrying developments for STEM is the removal of support for "higher specification and/or higher cost computers simply because of the way in which a course is delivered"[109]. This may have implications for disabled STEM students who might need a higher specification computer to interact with specialist course software. Further it is very concerning that DSA funding will now only be provided for "the most specialist non-medical help (NMH) support"[110]. Depending on the definition of 'most specialist' this could mean that there will be no funding for readers, note takers, learning support or mentors for disabled students. Such support workers help to make higher education and science or engineering study an option for many disabled people.

Currently one in 20 first degree students are in receipt of DSA, around 53,000 full-time undergraduates[111], up from one in 25 in 2005/06[112]. There is significant variation across disciplines, however over the last six years the percentage of full time students in receipt of DSA has risen across all STEM areas (Figure 5).

The increased uptake of DSAs highlights that more students are claiming their allowances and receiving the support that they need to study. DSAs currently cover various disability-related HE study needs and are available to all home-funded students, whether undergraduate or postgraduate, and part-time students can claim on a pro-rata basis. Postgraduates who are funded by Research Councils can apply to their Research Council for financial support to cover their costs along the line of the undergraduate DSA[113]. While the undergraduate DSAs are funded at an upper limit per year of the course, the postgraduate DSAs have an upper limit for the entire duration of the

Figure 5 –
Percentage full time first degree students in receipt of DSA

Source: HESA

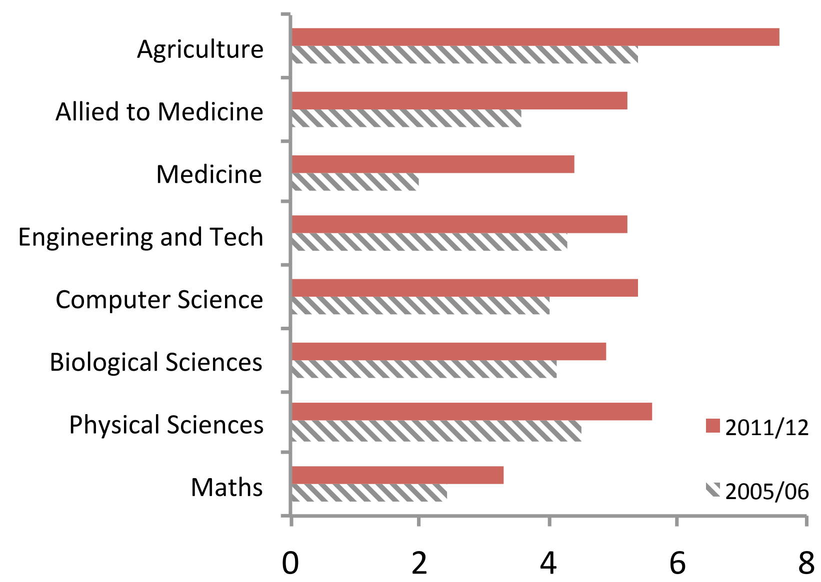
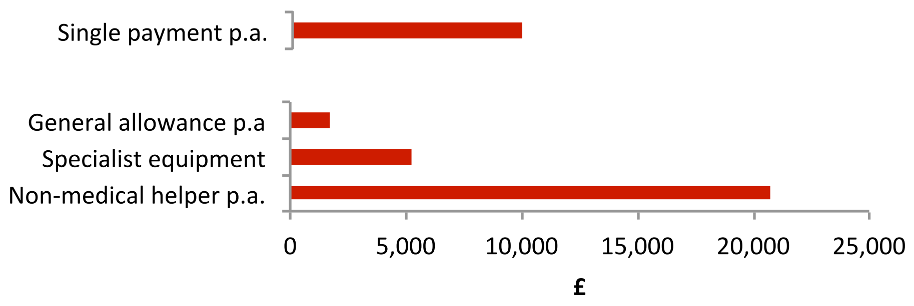


Figure 6 –
DSAs for full time students, 2014



course. Since 2008/2009 the DSA for those on taught postgraduate programmes has seen a below inflation increase of £362[114]. Up to 2014-15 there were large discrepancies between the support available for undergraduates and postgraduates, as shown in Figure 6.

The link between DSA and improved retention suggests that students are being properly supported. Previously CaSE has called for the significant disparity between funding for undergraduate and postgraduate courses to be addressed[115] as the concern is it could discourage disabled students from continuing and succeeding in postgraduate STEM study. In general a lower proportion of STEM students go on to postgraduate study than non-STEM students. However, as shown in the figure below, this is particularly pronounced for disabled STEM students. Disabled Non-STEM students are 38% less likely to progress to postgraduate study than their non-disabled peers. Disabled STEM students are less than half as likely (57%) to take up postgraduate study.

At present the DSA offers prospective disabled students a degree of certainty and a minimum entitlement of support for their studies. Universities already contribute to the additional costs and resources associated with supporting and teaching disabled students, as they should. However, the proposed changes will only act to penalise those institutions that have so far been successful at attracting disabled students and disincentivise institutions from doing so in future.

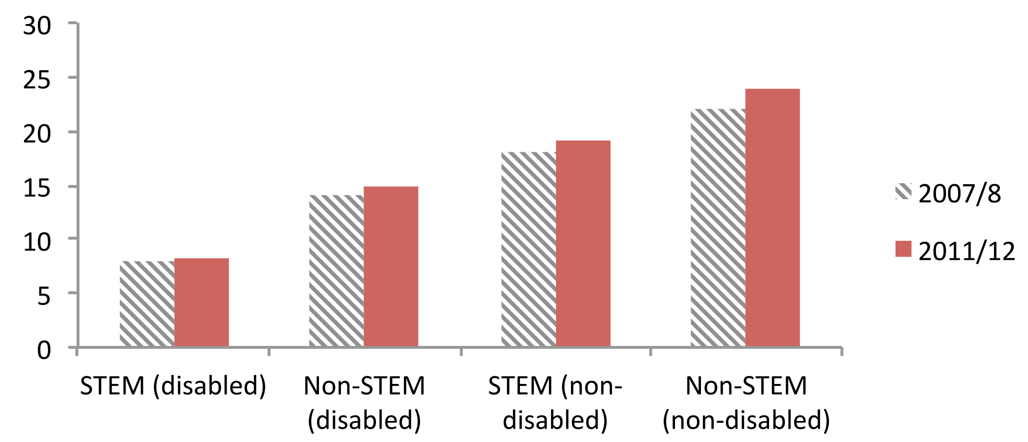
CaSE want to see the DSA come more into line with the Access to Work grant scheme that provides financial support for disabled workers and is circumstance dependant, not capped[117] and is therefore tailored to individual requirements. University study has clear benefits on employment outcomes. It is therefore inconsistent that the Government offers less support to disabled people in education than to those in the workforce. In light of the announced changes to support, CaSE again urges the Government to rethink its support for disabled students and to lift the caps on financial support for disabled students to bring it in to line with support for employment.

The Student Opportunity allocation distributed by HEFCE is an important source of funding for universities, contributing towards the additional costs of teaching and supporting disabled students, as well as those from disadvantaged backgrounds. Treasury should treat Student Opportunity funding as an investment with an associated financial return, not simply a cost to be minimised.

Government should also demonstrate their commitment to supporting diversity in higher education by securing the future of Student Opportunity funding beyond 2015-16[118].

It would be helpful for HESA to collate and publish sector wide levels of participation, retention and success (both in study and employment outcomes) of disabled students as part of their publicly available performance indicators, disaggregated by subject area and level of study. Universities should then be encouraged to monitor their performance against national baselines and take action to improve. Universities' access agreements submitted to the Office for Fair Access should all include what actions the university will take to improve access, retention and success for disabled students.

Figure 7 –
Postgraduates as a percentage of undergraduates varies by subject and disability status[116]



ACTIONS: DISABILITY AND STEM

The government should return to the Peter Little review and include its recommendations on disability in guidance and requirements to employers and training providers looking to access funding for apprenticeships

CaSE calls for a drive to improve awareness for school leavers and their advisors of the support available for disabled students wishing to pursue higher education STEM courses

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5) GENDER AND STEM

In terms of diversity in STEM, participation and progression of women in STEM from school through to academia and industry is the area where there has been the most data collection, debate, comment and intervention across the UK[119,120,121,122,123]. As Women into Science and Engineering (WISE) stated at the beginning 2014, their 30th anniversary year, "Things have moved on since 1984, when only 7% of those studying engineering at UK universities were female, but there is a long way to go if we are to achieve the critical mass of 30% women in the science, technology and engineering workforce"[124]. In this landmark year for WISE, gender diversity is taking centre stage in other long established institutions. For the first time the Royal Institution has an all women line-up for 2014's monthly Friday Evening Discourse series[125] and many more learned societies and professional bodies have female presidents, including for the first time the Royal Academy of Engineering, the Royal Society of Chemistry and the Royal Society of Edinburgh. However, that this is noteworthy is a pointer to the slow pace of progress.

These are positive landmarks, but it remains that girls are less likely than boys to aspire to science careers, even though girls are more likely to rate science as their favourite subject at school[126]. Women are consistently under-represented in STEM, particularly in the higher levels of academia and industry. For women in STEM careers, gender inequalities are seen in, for example, earnings[127,128], hiring decisions[129] and citations[130]. Despite the introduction of many different policies, funding streams and campaigns aimed at levelling the playing field, there remain many cultural and structural barriers to women in science and engineering. To move on, it is essential that individuals and organisations recognise this is still an issue and funding and effort are coordinated and put into interventions that have been evaluated and found to work.

DIVERSITY AND STEM STEREOTYPES

The choices young people make about education and careers are shaped by a combination of cultural messages, peer and parental pressures, their interaction with other role models and their individual self-determination. From the start, children are confronted by gender stereotypes with girls' toys and boys' toys[131,132], are influenced by stereotypes about "men's work" and "women's work"[133]. By GCSE level, gendered career ambitions are clearly evident[134]. A recent report from Science Grrrl helpfully unpacks the issues with, and solutions to, deeply embedded STEM and gender stereotypes. Stereotypes are simplistic generalisations about a group of individuals and often lead to bias which results in errors in decision making[135]. This may, for instance, result in girls considering that 'STEM is not for me', or lead to favouring male over female candidates in hiring or funding decisions. The Women into Scientific Careers report[136] recommends that Government should work with the STEM community and schools to tackle gender and STEM stereotypes. At present boys are much more likely to access STEM-related work experience[137]. The STEM stereotype could begin to be broken down for instance through providing opportunities to for girls and boys to equally access a variety of STEM work experience[138]. Schools should monitor the STEM work experience opportunities offered to and taken up by their students by gender and then work to address the balance if necessary. Alongside this, the compulsory training for teachers in combatting unconscious bias in their teaching, as raised in the Teaching Diversity section, is key to addressing bias linked to gender stereotyping. As part of this, rather than further campaigns and messaging conflating the gender and STEM stereotypes saying that 'STEM is for girls too', any messaging should aim to break down the 'masculine' STEM stereotype and the narrow male and female gender-stereotypes to focus on STEM being for everyone.

The stereotyping of careers by gender is evident in the careers advice young people receive[139] and in parents' career aspirations for their children. In a BIS survey on career choices there were striking divisions in parents' responses depending on the child's gender.

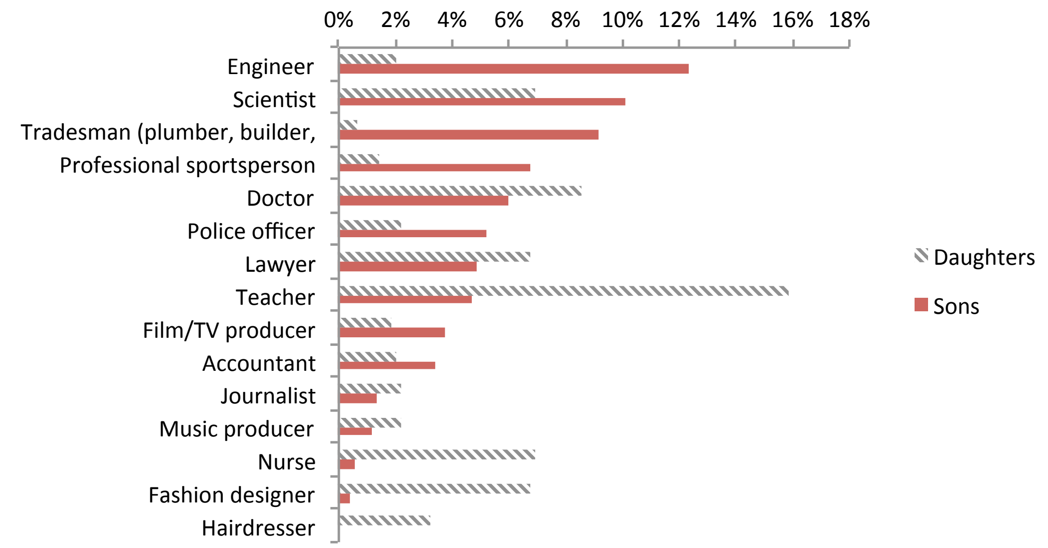
GENDER AND EDUCATION

At school level, the same proportion of girls and boys take all three sciences up until age 16. At A-level however, some gender gaps appear, slightly in favour of girls for biology with larger gaps in favour of boys for mathematics and physics[141,142].

The number of females taking Chemistry, Physics and Mathematics A-level has increased, but at a lower rate than for males. This does mean that nationally, more young people of both sexes are studying STEM subjects, which is to be celebrated. An often quoted figure is that only one in five A-level physics students are female, a proportion that has not improved in 20 years[143]. The uptake of physics does vary by school type with independent and single sex schools enrolling a higher proportion of girls to study STEM A-levels. Nearly half of state schools, however, didn't send a single girl on to do A-level physics[144]. In Wales figures even are more worrying. In 2013 there were falls in the number of girls studying every science subject at A-level, alongside an increase for boys. This was most pronounced in Physics with an 11% fall for girls but a 5% increase for boys. It is a crisis in participation, not performance with girls outperforming or matching their male peers' grades[145]. In recognition of these issues, the Stimulating Physics Network[146] was created, supporting teachers and schools to improve the quality of pupils' experience of physics

Figure 8 –

Parents' responses[vi] to the question "What type of job would you most like your child to pursue when they finish their education?" show gender bias[140]



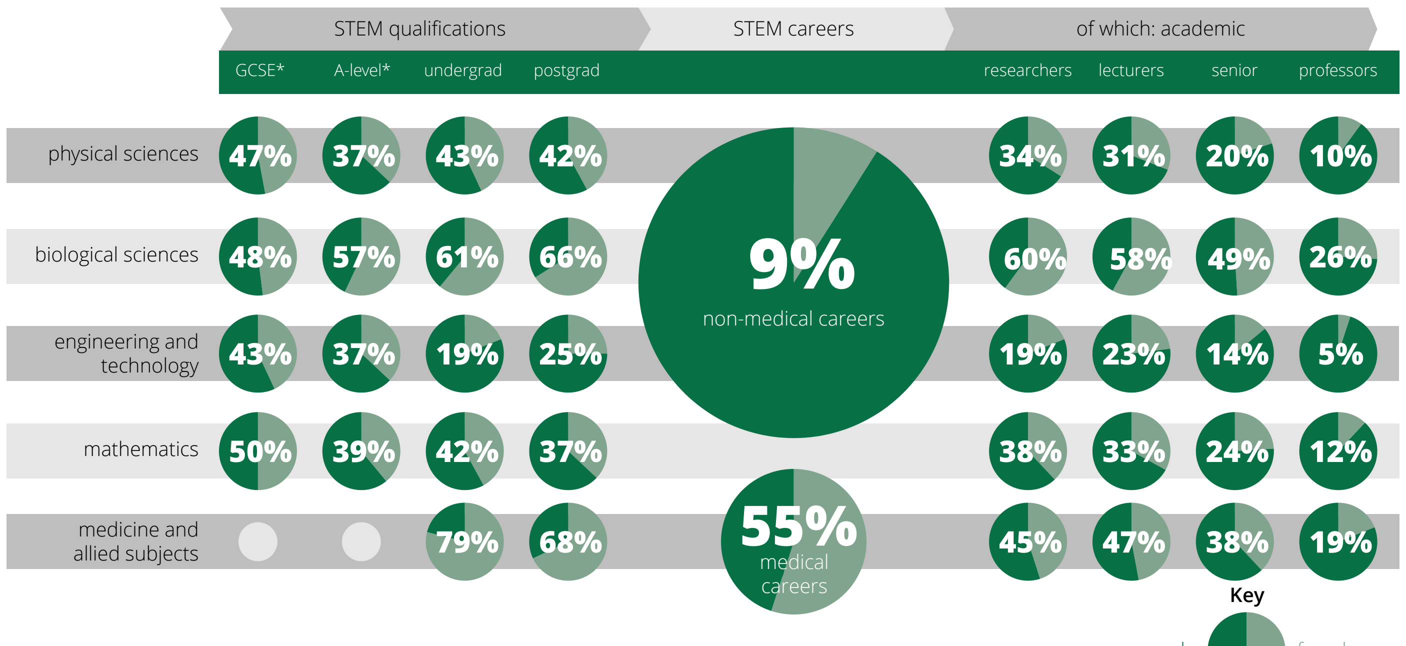
[vi] This survey shows responses before and after Tomorrow Engineers Week (TEW). The responses used here are of those surveyed after TEW and exclude 'don't know' and 'other' responses.

and in turn increase participation. This initiative should continue to be supported by government. We would also echo the recommendations from the Closing Doors report[147] that school accountability measures should include an indicator of progression to and success at A-level and other post-16 qualifications by gender. Schools should then reflect on their own statistics and put in place whole-school measures to counter gender stereotyping.

One study showed girls being less likely than boys to report that they are encouraged to continue with physics post-16 by their teacher. The same pattern was seen with perceptions as to how well teachers explain physics. This is particularly concerning as these factors were highly correlated with intention to continue physics post-16[148]. This is just one example of how unintended bias by teachers could be contributing to low participation and raises the importance of the recommendations around teacher training and CPD to equip teachers to recognise and eliminate unconscious bias in their practice.

Over the last two decades the academic performance of girls has greatly improved in STEM areas, but this is not always reflected in their subsequent career aspirations or economic success. They outperform boys at GCSE, A-level and degree standards. However, there are clear gender differences in higher education course choices, through to postgraduate and into the workforce as seen in figure 9. Interestingly UCAS data on course choices also show similar trends to the parental responses in figure 8, with Engineering heavily favoured by male applicants and nursing and education heavily favoured by female applicants[149].

Figure 9 –
Participation and retention across STEM from school through to the workforce[150]
(Designed by Scienceogram)



Percentages of women in STEM fields
Sources: WISE Campaign; Higher Education Statistics Agency

* reflects number of qualifications obtained

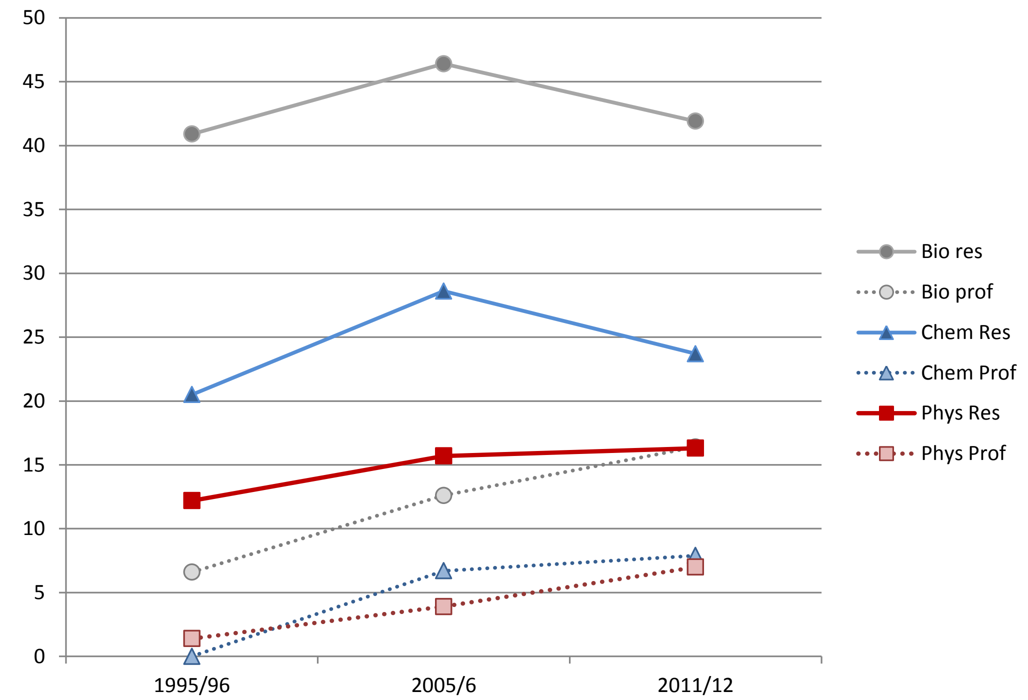
STEM subjects were found to account for 35% of the HE qualifications achieved by women in 2010/11, which is a decrease since 2006, instead returning to 2003 levels. More female undergraduates are studying languages than are studying engineering, computing, physical sciences and mathematics combined. The number of male undergraduate students in these scientific subjects is more than three times that of female students[151].

GENDER AND ACADEMIC CAREERS

One of the issues that has been most widely discussed is the so-called "leaky pipeline" whereby the proportion of women reduces significantly at each successive level in academia and also across STEM industry. The wider trend is that female STEM participation decreases as the seniority of positions increases. In the 2008 Delivering Diversity report the failure of the critical mass approach was discussed using the example of biological sciences where the gender balance is in favour of women at A-level and undergraduate level. However, at postgraduate study and beyond women are increasingly in the minority[152]. Similarly in 2012, 43% of senior lecturers and lecturers in academic medicine were women but just 16% of professors[153]. The solution to increasing female representation in STEM study and careers cannot simply be a case of increasing the number of women who choose STEM study post-16, but must also address barriers to progression.

When the age of staff is taken into account, women are less likely to have progressed to professorial level than men across all subject groupings[154]. Across the sector in 2011/12 females made up 21% of professors and 45% of academic staff[155]. The first female Professor of Physics was appointed

Figure 10 –
Percentage of academics that were female by subject and level (1996-2012)



in 1991. There has been progress since then but the floodgates have not opened. In 2009 there were 36 female physics professors in the UK – out of 650[156]. In the three sciences, shown in figure 9, the proportion of professors that are female is still below the sector average of 20%, even in biosciences[vii]. There are some signs of improvement in the proportion of female professors but with reductions or levelling out of numbers of female researchers, the upward trend shouldn't be assumed.

As seen in figures 9 and 10 the challenge is different in different disciplines. However, across all disciplines culture change is crucial if significant steps forward are to be made. Since 2007, Project Juno, an Institute of Physics programme, has seen massive advances in some Physics departments that have worked hard to tackle the barriers affecting the recruitment and retention of female academic staff. Similarly the Athena SWAN Charter was founded in 2005 and is run by the Equality Challenge Unit. It has seen dramatic growth in award applications and the impact report from 2011[157] found some significant improvements. Some of the issues tackled include: the scheduling of meetings to better suit those with caring responsibilities, ensuring female representation on key decision making committees, and giving visibility to the achievements of female staff[158]. Improvement is possible in a short timescale and now needs to become the norm rather than the exception across UK higher education if the pace of change is to exceed glacial. The Government should commit to adequate funding to support the ongoing work of the Equality Challenge Unit on the Athena SWAN Charter.

A range of surveys and studies suggest structural and cultural reasons for women leaving the academic workforce. Recurring issues include the attitudes of colleagues, expectation of long working hours, a male dominated working culture, and a sense of isolation[159,160,161]. Additionally, while there have been many studies into discrimination in scientific fields, some refuting that there is sexism in peer-review, hiring or grant applications[162], some research suggests both men and women view female applicants, with identical qualifications to male applicants, as being less capable and deserving a lower salary[163]. Recent evidence also shows that women are less successful than men in getting grants from Research Councils UK (RCUK) across all age and grant categories - women averaged a 25% success rate, compared with men's 29%[164]. In response one research council is launching unconscious bias training for peer-reviews. This is welcome but must spread further. Unconscious bias training should be made mandatory for all members of grant-awarding boards and panels across all 7 Research Councils. Further, given the significant drop off at higher career stages, particularly at professor level it should also be required for all those on appointment panels in universities.

In 2011 funding from biomedical research centres and units was linked to the attainment of a silver Athena SWAN award[165]. In 2013 the Government announced that it would be linking capital funding for STEM to evidence of a commitment to equality and diversity. One of the Research Councils' four aims is to promote and lead cultural change in relation to equality and diversity. It is also one of their stated requirements of all organisations that they fund[166]. However, linking funding to a specific award isn't always straightforward nor the best

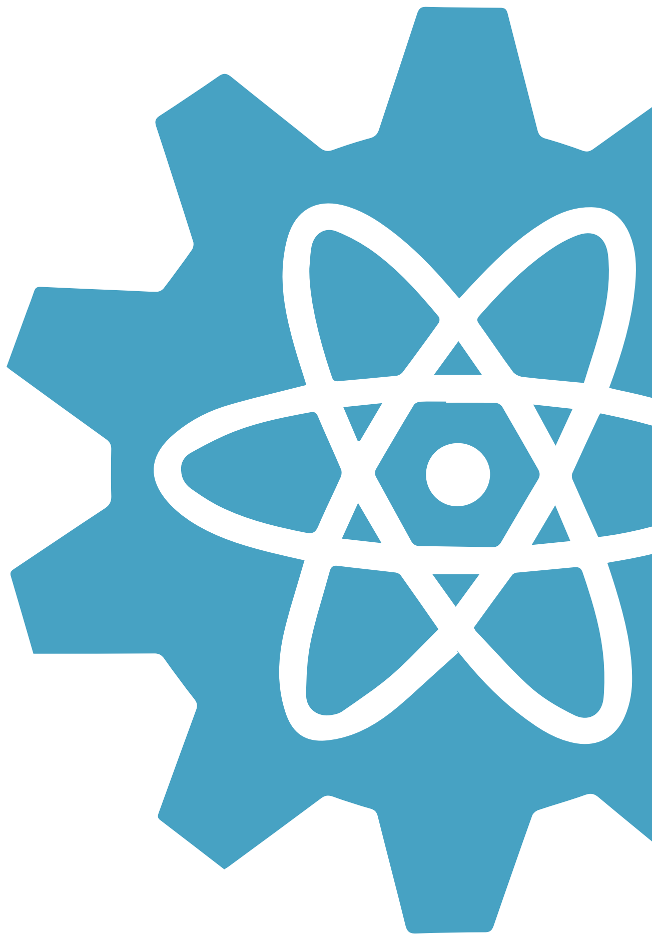
[vii] In their report, Sustainability of the UK research workforce (2009), RCUK present more detailed charts showing the percentage of female staff at each level across a wide range of disciplines

course of action[167]. CaSE welcomes this kind of approach and would like to see the option of using other levers, beyond simply funding, to increase the pace of change. For instance industry bodies could withhold professional accreditation of courses that fail to meet certain diversity measures or a STEM equivalent of the 30 percent club[viii,168] could be created, championing professional bodies, universities, university departments, businesses or Research Councils in which females hold over 30% of their senior positions (be that their board, professorships, membership or fellowship). There are some existing campaigns to see women make up 30% of the STEM workforce by 2020[169,170]. This could be a way of working together to incentivise and champion success.

Women are under-represented across other indicators of achievement, including Academy fellowship, but with a focus on improving diversity in recent years progress has been made. In 2006 less than 2% of fellows at the Royal Academy of Engineering were female. Since they began taking action to address the imbalance in 2007, every annual intake of fellows has been 10-15% female with the overall proportion now at 4% of the fellowship. They have also created the Diversity in Engineering Concordat currently signed by around 30 Professional Engineering Institutions aiming to get the profession taking action to improve diversity. Similarly at the Royal Society only 5% of fellows are women[171] and since 2000, 10% of new fellows have been women. The Royal Society has introduced Temporary Nominating Groups seek out and support credible candidates for nomination across a number of underrepresented areas within the Fellowship, including women. It is a positive step forward. Concurrently, as the election process operates by nomination from existing Fellows, rather than by application, the reasons why candidates may not have been nominated for Fellowship through the traditional channels needs to be addressed[172,173]. As part of their drive to champion diversity the Royal Society have in place measures to check that the speakers at conferences they host are appropriately diverse.

WOMEN IN INDUSTRY

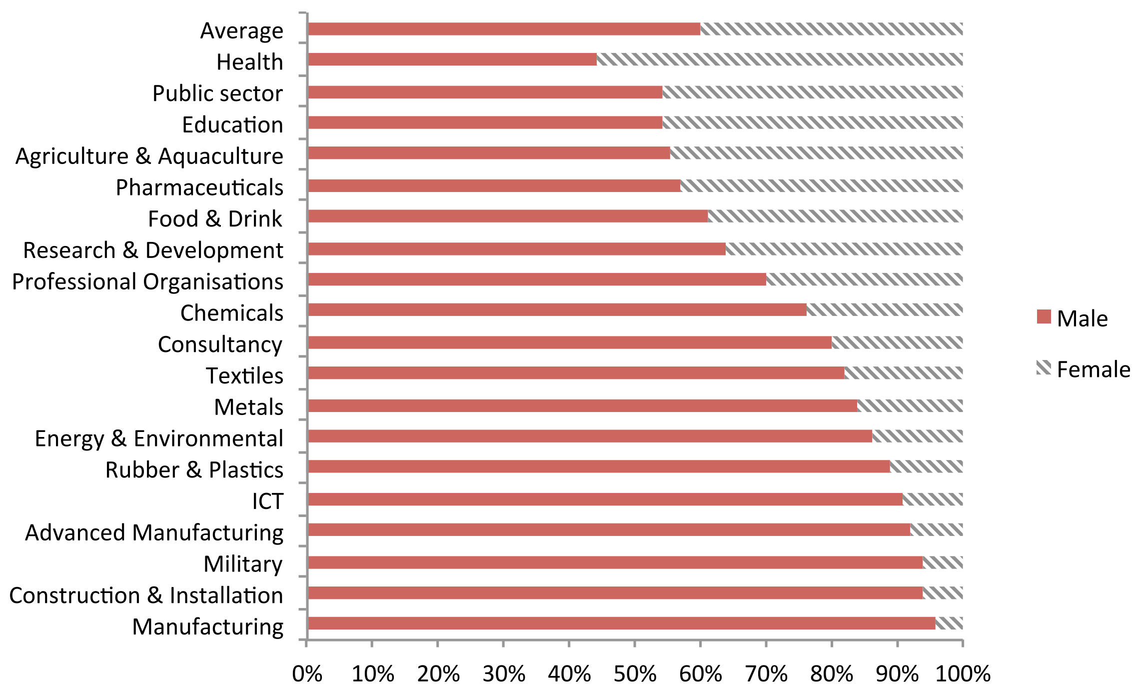
Since the 2008 Delivering Diversity report there have been welcome improvements in the volume and quality of data available on women in STEM careers outside of academia. Only 13% of those employed in STEM occupations, and only 10% of STEM managers, are women[174]. Furthermore, the overall numbers can give a skewed view of what is happening in different STEM sectors and there are difficulties when comparing across data sets as



[viii] The 30% is based on research that suggests it is the proportion when critical mass is reached – in a group setting, the voices of the minority group become heard in their own right, rather than simply representing the minority.

Figure 11 – Proportion of primary science workers across STEM sectors by gender[175]

Source: Science Council analysis of Annual Population Survey (2009)



there is no consistent definition of a STEM worker. However, figure 11 shows a breakdown by gender of primary science workers[ix] in each sector.

Around 60% of the primary science workforce is male, whereas in this analysis the balance is tipped in favour of women in the secondary science workforce - in particular, across health, education, pharmaceuticals and textiles[176]. That 40% of primary science workers are women masks just how drastic the situation is in some other parts of the sector, as seen in Figure 11. Again there are two different factors to consider; access and progression. Even in sectors such as health and education where the numbers appear more balanced, there isn't room for complacency as women are still less likely than men to hold senior positions.

Gender occupational segregation is particularly extreme in STEM skilled trades, with women forming 1% of these occupations in 2008, with a tiny growth of 0.1% since 2003. Women account for only 6% of the construction scientific workforce[177]. The recent Perkins' Review highlighted that only 8% of British engineers are women, the lowest proportion in Europe, compared to Germany (15%), Sweden (25%) and top-performing Latvia (30%)[178].

Engineering University Technical Colleges (UTCs) are struggling to recruit girls[179]. Aware of this imbalance the JCB Academy attempted a radical move to rebalance numbers by keeping a certain numbers of places for girls, but were legally challenged on the grounds of sex discrimination. It may be good to consider whether new UTCs should be set up as a pair of single sex schools; evidence shows that girls in single sex girls' schools are more likely to continue studying STEM beyond 16 and it could facilitate a more equal balance between girls and boys being educated at UTCs. For all UTCs, WISE have created a resource[180] for those in leadership outlining the business case and the social case for diversity in STEM. It provides practical advice and access to resources that will support UTCs to engage and inspire girls and young women to pursue STEM education and careers. University Technical Colleges have the potential to positively impact diversity in STEM and should be monitored for diversity of intake and uptake of STEM by diversity characteristics.

This gender imbalance also persists in STEM apprenticeships. In 2011/12 half of all apprenticeship starts were female. However, women are significantly under-represented in the STEM and higher-pay sectors such as engineering (4%), while men are under-represented in lower-pay sectors such as the children's and young people's workforce (7%)[181,182]. A recent survey of young professionals showed that a third of the men questioned were encouraged to take an apprenticeship in school. Just 17% of women received the same advice[183].

Across vocational education the picture is worrying, with low and declining uptake by females of STEM vocational qualifications. The number of females achieving Engineering and Manufacturing Technologies NVQs/SVQs was already low and in 2011 declined by a further 8% compared to a 19% increase for males over the same period. Pilots looking at how to increase diversity within apprenticeships found that although employers saw the main issue was low demand for apprenticeships from young women, not all employers had considered unconscious bias in recruitment

> "With collective effort it is possible to see significant improvement in diversity within senior positions within a short period of time"

practices and work environments[184]. The UKCES-funded Women into STEM apprenticeship programme in 2012 aimed to attract more female applicants, but was limited in scope and was not integrated into Apprenticeship policy more widely. Actively improving diversity must be considered central to the development, design, promotion and evaluation of the new Level 2 and 3 qualifications and apprenticeships that the Government and the engineering community will be developing following the Perkins Review[185] to create high quality vocational routes for 16-19 year olds to enter engineering careers. Similarly, government should ensure that any other initiatives and events around STEM are designed and implemented with consideration given to how they can positively contribute towards the diversity in STEM agenda.

Research suggests European listed companies with greater gender diversity in top positions outperform sector averages[186] and are more effective[187]. Women remain a small, but growing, proportion of Board members in SET FTSE 100 companies. In 2004, only 8% of SET Board directorships were held by women. In 2011, the FTSE100 were set the ambition by Lord Davies and his Steering Group for women to account for 25% of FTSE 100 boards

[ix] Primary science workers are those in occupations that are purely science based and require the consistent application of scientific knowledge and skills in order to execute the role effectively. E.g. Chemists, Science & Engineering Technicians or Pharmacists. Secondary science workers are in occupations that are science related and require a mixed application of scientific knowledge and skills alongside other skill sets. E.g. Conservation & Environmental Protection Officers, Environmental Health Officers, Teaching Professionals.

by 2015. This voluntary approach, combined with a concerted effort from industry[188], has seen significant success in the last three years; women now account for 25% of FTSE100 non-executive board positions, up from 13% in February 2011[189]. Whilst there is movement in the right direction, the only two remaining companies with all-male boards are STEM businesses and in general STEM companies still lag behind[190]. However, there are shining examples within STEM; Diageo Plc, a STEM company, tops the list with its Board being 44% female[191]. The FTSE250 have now also been encouraged to increase female representation and aim for 25% of women on boards.

This approach does show that what is monitored makes a big difference to action, clearly shown by the fact that although there have been big improvements in the proportion of women in non-executive posts, only 7% of executive posts in FTSE 100 companies are held by women. With collective effort it is possible to see significant improvement in diversity within senior positions within a short period of time. There seems to be value in taking a voluntary approach. Significant change can happen quickly. We need to build on this approach across other sectors, including government, public appointments, professional bodies, universities and industry to drive forward change.

ACTIONS: GENDER AND STEM

Schools should monitor the STEM work experience opportunities offered to and taken up by their students by gender and then work to address the balance if necessary

Any messaging should aim to break down the 'masculine' STEM stereotype and the narrow male and female gender-stereotypes to focus on STEM being for everyone

School accountability measures should include an indicator of progression to and success at A-level and other post-16 qualifications by gender. Schools should then reflect on their own statistics and put in place whole-school measures to counter gender stereotyping

The Government should commit to adequate funding to support the ongoing work of the Equality Challenge Unit on the Athena SWAN Charter

Unconscious bias training should be made mandatory for all members of grant-awarding boards and panels across all 7 Research Councils

STEM equivalent of the 30 percent club could be created, championing professional bodies, universities, university departments, businesses or Research Councils in which females hold over 30% of their senior positions (be that their board, professorships, membership or fellowship)

University Technical Colleges have the potential to positively impact diversity in STEM and should be monitored for diversity of intake and uptake of STEM by diversity characteristics

Actively improving diversity must be considered central to the development, design, promotion and evaluation of the new Level 2 and 3 qualifications and apprenticeships that the Government and the engineering community will be developing following the Perkins Review

Government should ensure that any other initiatives and events around STEM are designed and implemented with consideration given to how they can positively contribute towards the diversity in STEM agenda

6) SOCIAL DISADVANTAGE AND STEM

There remains a stubborn link between educational attainment and socioeconomic background in the UK. De-coupling performance in science and mathematics (and other subjects) from socioeconomic background should be a priority for government. When one in six children in the UK – 2.3 million – is officially classified as poor, it exacts a high social price. Furthermore, it is estimated that raising all children to current average levels of educational attainment could contribute £56 billion a year by 2050, the equivalent of 4% of UK GDP[192]. Socio-economic status can have a profound impact on students' engagement with science[193]. Social disadvantage is not a static characteristic and can change over a person's life. Indeed, opening up STEM study, training and work is a way to open up life changing opportunities.

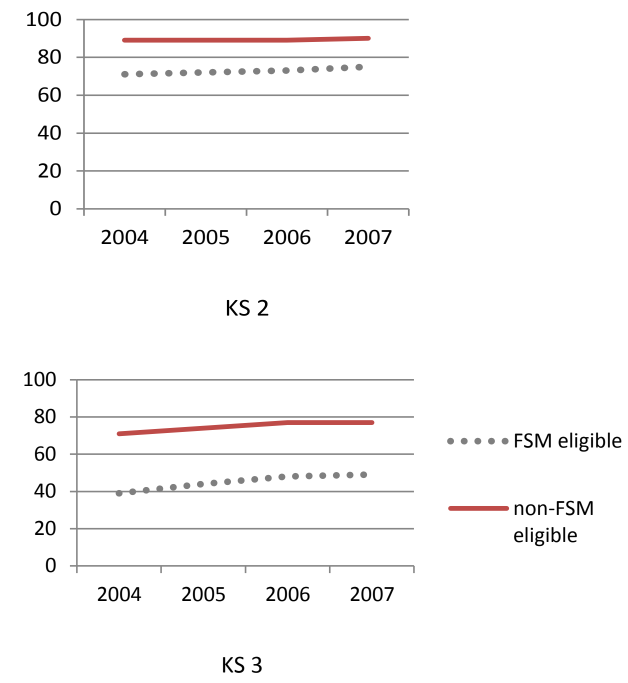
SOCIAL DISADVANTAGE AT SCHOOL

In recent years the attainment gap between the poorest and wealthiest children has narrowed at primary school and GCSE-level but widened at A-level. Looking at Ofsted ratings, the most deprived areas still have 30% fewer good schools and a lower proportion of their teaching is rated good or outstanding than in the least deprived areas[194]. This is particularly concerning as studies show that the effects of high-quality teaching are especially large for pupils from disadvantaged backgrounds, who gain an extra year's worth of learning under very effective teachers compared to poorly performing teachers[195].

Looking specifically at science, figure 12 shows there are clear achievement gaps between students eligible for Free School Meals (FSM)[x] that widen between Key Stage (KS) 2 and KS3.

Figure 12 –

Percentage of pupils achieving the expected level in science varies by FSM eligibility[196]



[x] In England, children may be entitled to receive FSM if their parents receive certain support payments and it can be used as a measure of disadvantage.

There is some evidence that the removal of SATs has had an impact on the teaching of science in many primary schools and mostly in negative ways, such as reduced lesson time and the perception that science is less important than other core subjects[197]. Mathematics and science are both core subjects and must both be treated as such by schools and by Ofsted in the way they are monitored. The brunt of the impact will likely be felt in schools where basic numeracy and literacy are more of a challenge. These are both central to success in STEM as well as more broadly. Therefore it would be beneficial to integrate numeracy and literacy learning into science education, rather than to focus on them at the expense of science education[198]. This already happens in some schools but could be developed further. Part of the ongoing role of an expert subject leader should be to remain up to date through regular subject-specific CPD. Primary schools should nominate an expert subject leader for science. Resources to nurture science subject leaders should be initially focused on schools in deprived areas.

Similarly, at secondary school, pupils in schools with high numbers of students receiving FSM or higher numbers of students with SEN are less likely to be taught science by a specialist teacher for each of the sciences[199]. In particular, only 19% of science teachers across the system are physics specialists. As the level of specialist qualification of the teacher has been found to be the second most effective predictor of pupil performance in physics, this is deeply concerning[200]. In mathematics, a quarter of teachers had not studied maths to degree level nor as part of their initial teacher training. The Government must work with schools and teacher training providers to both increase the number of science and maths teachers and to target specialist science and mathematics teachers into the schools in more deprived areas.

CaSE welcomes the initiative from the Department for Education exploring how individuals with physics and mathematics qualifications at different stages of their career could be recruited and trained as teachers. CaSE also welcomes the recent announcement of incentives for recruiting mathematics teachers, including additional funding for those who go on to teach at FE colleges[201]. As the purpose of this funding seems to be to improve the quality and supply of teachers, this mechanism could also be used to encourage specialist mathematics or science teachers into schools with, for instance, high proportions of FSM eligible students.

Further, despite grants and some excellent CPD available, time, funding and lack of priority by managers can limit teachers' access to CPD. In one study half of all secondary science teachers surveyed had had no subject-knowledge professional development in the past five years, although science teachers are more likely than other teachers to seek subject knowledge updates[202]. The Subject Knowledge Enhancement (SKE) programme[203] is an important route to help address the imbalance of specialist teachers in science and is currently free to teachers in maintained schools and colleges and the school can receive supply cover funding. Across the system, but particularly in schools in more challenging circumstances where teachers are less likely to be specialists, improving awareness of, and mechanisms for, teachers to access subject specific CPD is essential to better support science teachers teaching outside of their own specialism.

In England, traditional STEM education from 14-16 consists of the mandatory study of science and mathematics, with little specific coverage of technology or engineering. Most pupils work towards one GCSE in mathematics and one, two or three GCSE's in science[xi]. Over the past 6 years there have been steps forwards in STEM areas and CaSE values the government's recognition that pupils should have the option to study three science GCSEs (the so-called "separate sciences" approach). In 2006 only 26% of mainstream schools (excluding Grammar schools) offered this option[204], however currently this figure has risen to 84% of state schools and 93% of schools overall[205]. But, while the increased provision of separate sciences is to be welcomed, such figures mask persisting social disadvantage.

In 2012, 83% of year 9 pupils at selective schools opted to study separate sciences whereas only 31% of state school students did the same. In addition, schools with a high Free School Meals (FSM) eligibility were found to have lower levels of uptake for the separate sciences[206]. Worryingly in 2011 the proportion of schools where it is compulsory for all pupils to study at least double science has fallen significantly, with more schools reporting it is only compulsory for their higher performing students[207].

CaSE believes that it is not enough to simply offer the courses, advocating that more must be done to increase uptake and ensure that teachers are equipped to enthuse students, as well as convey the message that a strong scientific education is both immediately satisfying and an investment for the future. The cost of more science provision in school may also be a factor; a recent Ofsted report found that schools that made science interesting for pupils raised achievement in science. The most effective approach to making science interesting was found to be through practically based investigations[208].

Funding for science practical work in schools is already constrained. On average, funding for practicals was £4 per student in 2011/12, falling as low as 75p in some schools[209]. The new minimum requirement of 12 practical activities at A-level is a necessary introduction to prevent practical work from being completely deprioritised now that performance in practical work will not form part of the A-level grade[210]. Schools should be adequately funded to ensure that student choice within science is never restricted due to cost. The Government should look at the infrastructure for practical science and target investment to bring up the lowest resourced to improve science education for the most disadvantaged.

There is also an important role for informal learning, both in science and numeracy. It affects motivation and attainment in science and like formal education opportunities can be skewed across social groups and geographical areas[211]. This should also be considered as policies and campaigns to improve interest and success in science and mathematics are explored.

[xi] The POST Note on STEM education for 14-19 year olds provides a more detailed breakdown of the GCSE options for science

Every young person while at school has a unique learner number (ULN) that is linked to their personal learner record. There could be value in recording the different interactions young people have with, for instance, STEM initiatives at school using the ULN. If the ULN then went with young people as the progress into further education or employment this would provide a rich data resource for evaluation of what works. It would be a large undertaking but could be rich resource for research into improving education outcomes more broadly. Improvements in technology mean that there could be a wide range of ways in which this data could be collected reliably, for instance using learning from approaches used to tracking retail purchases, and without increased burdens on schools.

PROGRESSION POST-16

There are many different routes into STEM careers, be it through further education, higher education, apprenticeships, or a combination of these pathways. Most English young people take some vocational courses before they are 16 and the majority follow courses which are largely or entirely vocational post-16[212]. Vocational qualifications and apprenticeships are available to everyone however at present are more likely to be taken by those from lower socioeconomic backgrounds and are often based in FE colleges[213].

Around one-third of the science workforce in the UK are non-graduates working with science skills in a variety of ways and many of these will be highly skilled technicians[214]. Across science and engineering there is a need for upwards of 450,000 new STEM based technicians by 2020[215]. However, there are concerns around the continuing provision of high quality, well-funded vocational STEM courses. There is considerable cost involved in providing some STEM programmes over and above other subjects and data suggest that the current programme weightings for funding science, engineering and IT in FE colleges may not adequately reflect the cost of delivering these practical subjects[216].

There are two possible outcomes of this situation continuing. FE colleges could choose to continue courses that are inadequately resourced and therefore unable to give students the practical experience and associated employment outcomes such courses should deliver. The alternative is that courses close and there is a reduction in provision of STEM courses across the UK at a time when those with STEM skills are in high demand. Neither is desirable and would lead to employers being less able to recruit the talent they need and young people being less equipped for the future. Government should look to address the Further Education STEM funding gap to ensure that STEM courses are feasible and high quality. It would otherwise be a disservice to students and a missed opportunity for investing in much needed skills.

The recent increase in participation age to 17, rising to 18 in 2015, will affect around 60,000 young people a year[217]. Evidence suggests that this group are most likely, under the new system, to move into jobs with training, vocational courses and courses leading to qualifications at Level 2 or below[218]. There is the potential for an increase in the number of young people studying STEM subjects or training in STEM occupations post-16 if STEM employers and training providers are able to provide, and communicate, opportunities which are both suitable and attractive to them.

Those taking apprenticeships in general experience lower funding, greater complexity and more variability in quality than university students[219]. As apprenticeships are developed in partnership

with employers, it is important to maintain the requirement that new standards should include skills which are relevant and valuable beyond just the current job, supporting progression within the sector. The new system for apprenticeships should link to registration standards, to ensure transparency and accountability of organisations involved in the system and clarity on the routes for employer involvement[220]. In science and engineering there are registration standards developed with the input of employers and the education sector. They are kept under review and provide transferability and progression pathways.

INTERNATIONAL COMPARISONS

From the Programme for International Student Assessment (PISA) study 2009, differences in family background were found to explain a quarter of performance differences in the UK[221]. Looking at maths performance detailed in the 2012 PISA study, on average a more socioeconomically advantaged student performed the equivalent of one year of schooling ahead of a less advantaged student. In line with the OECD average, a quarter (24%) of socially disadvantaged students 'beat the odds against them' and exceeded expectations when compared internationally with those of a similar socioeconomic background[222].

From the PISA studies, little has changed since 2006 in terms of the extent to which socio-economic background is linked to performance. This isn't something that we should assume will always be the case. There are international examples where the impact of socio-economic background on learning outcomes is moderated[223].

Interestingly Andreas Schleicher, the OECD's deputy director for education and skills and co-ordinator of the PISA programme, has said that the 2013 study showed little difference in performance between public and private schools in the UK, once socio-economic background is accounted for. Findings from PISA suggest that much of the advantage that comes from private schooling is related to the social-economic context, not necessarily in value added[224].

Focusing solely on raising standards in schools can only be part of the solution. There needs to be greater coordination and resources to build on initiatives to include parents and carers from lower socio-economic backgrounds in the education process. This is important as non-school factors, including informal science learning experiences, play a large role in attainment, interest and decision making[225].

HIGHER EDUCATION

As institutions that receive large amounts of public funding, UK higher education providers have a responsibility to ensure that participation in HE is fair and equitable. Since 2007/8 there has been an 18% increase in the number of students taking first degrees at university and 13% increase in postgraduate numbers[226]. A young person living in a low HE participation area is three times more likely to go into HE compared with the late 1990s due to improvements in prior attainment for these groups alongside large increases in overall participation. This is to be celebrated. However, large disparities still remain and need to be addressed[227].

Unfortunately, lower socioeconomic status may still be a barrier to STEM higher education in particular.

In an analysis of socioeconomic diversity in STEM higher education using HESA data, CaSE found that amongst undergraduate students in 2009/10, a better-than-average level, and rate of improvement, of socioeconomic diversity was found in the biological (32%) and computer sciences (39%). However, in the Physical (25%) and Mathematical (26%) sciences degree courses showed significantly lower levels of socioeconomic diversity - which have decreased since 2004 - than the average across all courses (30%)[228].

The findings should not suggest that well-performing disciplines do not still need to improve as participation gaps remain when compared against the total student population. The STEM community, along with government, has a responsibility to recognise these trends and ensure fair access to STEM education for people from all backgrounds[229].

CaSE has previously discussed possible reasons for the underrepresentation of students from lower-socioeconomic backgrounds in STEM subject areas[230]. For instance, as previously discussed, the UK's shortage of specialist science and mathematics teachers is particularly pronounced in socially-disadvantaged areas[231]. Also, independent school pupils are over-represented in entries for science and maths at A-level, whereas state school pupils are over-represented amongst arts and humanities subjects for the same metric[232].

Science and engineering are essential to the UK's society and economy and it is important that everyone with the ability and inclination is given the opportunity to study STEM subjects. Indeed, we speculate that one of the reasons for some STEM subjects performing better on socio-economic diversity amongst mature entrants (engineering and maths in particular)[233] is that students coming to higher education after spending time out of education, better recognise the potential future benefits of these subjects than their younger counterparts. It is important that the future benefits and opportunities available through STEM are made clear through Government messaging as well as through schools, colleges and careers advice to young people, their families and those looking to retrain.

> "It is essential that STEM postgraduate study is a feasible option for those who are not able to fund themselves"

There has been much public debate around the increase in fees for higher education, and concern that it would result in less people being able to afford university. Indeed there was a decrease in university applications linked to the increase in fees announced in 2010[234]. However, as seen with the fee increase in 2006[235], the drop in undergraduate numbers appears to be temporary and demand for higher education has subsequently picked up. As in 2006, application data did not show the disproportionate drop in applications from disadvantaged individuals that many had feared. An Institute of Fiscal Studies analysis found that for every £1000 increase in upfront fee cost resulted in a 4.4 percentage point reduction in participation[236]. However, university education remains free at point of use for first time students and they only begin paying back once they earn over £21,000.

Therefore, with regard to fees, socioeconomic background should not affect whether university is affordable and at present does not seem to be having a measurable effect on perceived affordability.

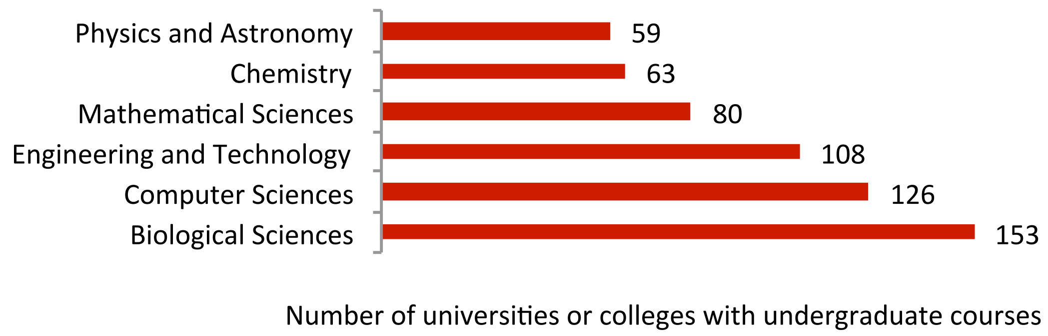
Although full-time undergraduate participation remains high, there are serious concerns about part-time participation and mature students which have seen sustained drops in applications[237]. Students in these groups are more likely to be from groups under-represented in higher education[238]. It was therefore welcome to hear that fee loans would be extended to part-time students in engineering, technology and computer science who already have degrees in different disciplines[239], removing one possible barrier to retraining. As the cap on student numbers is lifted in 2015, the opportunity to receive a fee-loan for retraining in STEM should be extended to students returning to higher education on a full-time basis.

There are also concerns around reductions in the number of students continuing to postgraduate study[240]. Postgraduate fees must be paid upfront and currently around 40% of postgraduate research students and over 60% of postgraduate taught students are self-funded[241,242]. With the urgent demand for more highly skilled STEM workers, including those at postgraduate level, it is essential that STEM postgraduate study is a feasible option for those who are not able to fund themselves. This is not currently the case. Postgraduate funding should be addressed alongside funding for undergraduates to ensure that as a whole the system is affordable, fair and fit for a high-skill, high-tech future.

There is an increasing trend for students to live at home while studying, particularly for those from lower socioeconomic backgrounds, mature students and other non-traditional students. Around 18% of students lived at home in 2012 up from 13% in 2008[243]. Therefore, as well as ensuring there is suitable funding available, the regional spread of provision of STEM courses is key. It is encouraging that there is widespread provision of STEM higher education across the UK as shown in figure 13.

The capital funding from government to support the additional costs of STEM provision is very welcome. CaSE calls for the monitoring of regional provision of key STEM subjects. Funding to support STEM provision should be prioritised accordingly to ensure that there isn't a concentration of STEM provision across the country that would negatively impact on the opportunities for STEM study for all. It is also possible that mechanisms in place for funding some PhDs in particular might reduce the number of institutions able to offer funded PhDs.

Figure 13 –
Number of universities or colleges with STEM undergraduate degree courses[244]



The Doctoral Training Centre (DTC) model should be monitored to ensure that this funding method for postgraduate research degrees supports socially disadvantaged students. There are many universities with high quality existing provision that aren't part of a DTC. Measures should be put in place to ensure that restricting funding to a smaller group of providers doesn't limit the extent of high quality provision across the UK[245] as this could damage the breadth and depth of the research base and would be likely to disproportionately affect the progression opportunities for students from lower socioeconomic groups.

ACTIONS: SOCIAL DISADVANTAGE AND STEM

Mathematics and science are both core subjects and must both be treated as such by schools and by Ofsted in the way they are monitored

Primary schools should nominate an expert subject leader for science. Resources to nurture science subject leaders should be initially focused on schools in deprived areas

The Government must work with schools and teacher training providers to both increase the number of science and maths teachers and to target specialist science and mathematics teachers into the schools in more deprived areas

Across the system, but particularly in schools in more challenging circumstances where teachers are less likely to be specialists, improving awareness of, and mechanisms for, teachers to access subject specific CPD is essential to better support science teachers teaching outside of their own specialism

Schools should be adequately funded to ensure that student choice within science is never restricted due to cost. The Government should look at the infrastructure for practical science and target investment to bring up the lowest resourced to improve science education for the most disadvantaged

Government should look to address the Further Education STEM funding gap to ensure that STEM courses are feasible and high quality

The new system for apprenticeships should link to registration standards, to ensure transparency and accountability of organisations involved in the system and clarity on the routes for employer involvement

There needs to be greater coordination and resources to build on initiatives to include parents and carers from lower socio-economic backgrounds in the education process

It is important that the future benefits and opportunities available through STEM are made clear through Government messaging as well as through schools, colleges and careers advice to young people, their families and those looking to retrain

the opportunity to receive a fee-loan for retraining in STEM should be extended to students returning to higher education on a full-time basis

Postgraduate funding should be addressed alongside funding for undergraduates to ensure that as a whole the system is affordable, fair and fit for a high-skill, high-tech future

CaSE calls for the monitoring of regional provision of key STEM subjects. Funding to support STEM provision should be prioritised accordingly to ensure that there isn't a concentration of STEM provision across the country that would negatively impact on the opportunities for STEM study for all

The Doctoral Training Centre (DTC) model should be monitored to ensure that this funding method for postgraduate research degrees supports socially disadvantaged students

7) ETHNICITY AND STEM

Ethnicity and STEM interact in a range of ways across education and in the workforce. The UK population is becoming ever more ethnically diverse as seen in Figure 14[246,247]. Scotland and Northern Ireland are less ethnically diverse than England and Wales, however both have also seen proportionate increases since 2001[248,249]. It is, therefore, of great importance to ensure that policy, culture and practice across education, industry, recruitment and promotion do not negatively impact on those from a particular ethnic group. As with other aspects of diversity, the motivation is two-fold: to maximise individual opportunity and to meet economic need.

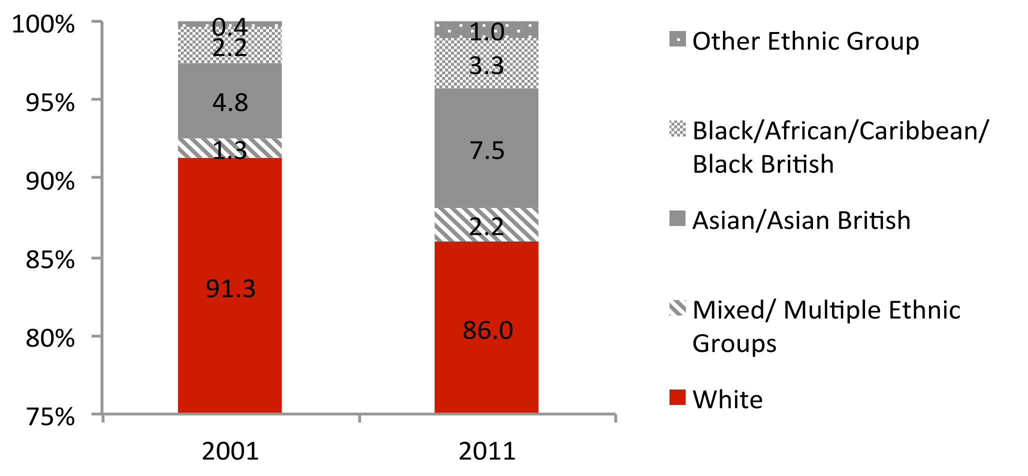
ETHNICITY IN THE UK

With 18 different ethnicities on England and Wales's census, 19 on Scotland's and 16 on Northern Ireland's, populations are often bracketed by broad categories, as shown in the breakdown of census information above. However this could cause confusion and mask important trends when considering how ethnicity interacts with different aspects of STEM. Looking at educational data, for example, Pakistani and Bangladeshi pupils underperform against the national average at KS2, while Chinese students perform above average, yet all three groups could fall under the broader label of "Asian"[250]. However due to statistical reasons, or for comparison of trends between countries, it is sometimes necessary to use broad groups, or even all-encompassing terms such as "Black and Minority Ethnic" (BME).

ETHNICITY AND EDUCATION

Department for Education reports have shown that differences in educational achievement can be seen across a range of ethnic groups from an early age[251]. In England and Wales children with an Indian or Chinese background perform better than the national average in science at KS2, while Pakistani,

Figure 14 –
Change in Ethnic Group as a percentage of the Population (England and Wales)
Source: Census data, ONS



Bangladeshi and Black African and Caribbean pupils perform below the national average. Looking at trends across the years, from 2004 to 2009, the performance of Indian, African, Pakistani and Bangladeshi pupils all show a notable rise in the proportion of pupils meeting the national average at KS2, suggesting that gaps in attainment are decreasing[252]. However, even after controlling for prior attainment and other factors Black Caribbean pupils have been found to be under-represented in entry to the higher tiers of science and mathematics at KS3[253] and are disproportionately encouraged onto vocational courses[254].

Other research has shown that it is not only attainment, but also perceptions of STEM related careers that may vary between ethnic groups. A study by the University of Derby showed that non-White British children at KS3 were more likely to consider a career in 'science, mathematics and statistics' than White children, as well as having a more favourable attitude towards taking up a career in 'computers and IT'. Engineering displayed the reverse trend, although the gap was far smaller[255].

It seems likely that such attitudes feed in to post-16 choices, which in turn influence career options.

A study into GCSE and A-level uptake by ethnicity showed that while Biology, Chemistry and Maths was the most popular A-level combination for all ethnic groups in 2007, the preference for this combination was far lower for White students compared to those from other ethnic groups (Figure 15)[256]. The widespread differences between ethnic groups demonstrate the complex cultural backdrop to the STEM diversity agenda.

There have been two policy changes in recent years that may disproportionately affect BME students. The ethnic minority achievement grant, designed to help underperforming BME pupils, has now been encompassed in the dedicated schools grant – the money is still available, but is no longer ring-fenced[258]. In addition, there is some concern that the removal of the Education Maintenance Allowance (EMA) in England, which provided around £560 million to 16-19 year olds in education[259], could be detrimental to students belonging to ethnic minority groups. It is likely to have a large impact on Pakistani and Bangladeshi students in particular as 77% and 88% respectively of 17-18 year olds in full time education from these ethnic groups were in receipt of EMA in 2008[260].

Figure 15 –
Percentage of A-level candidates taking three A-levels who studied Biology, Chemistry and Mathematics[257]

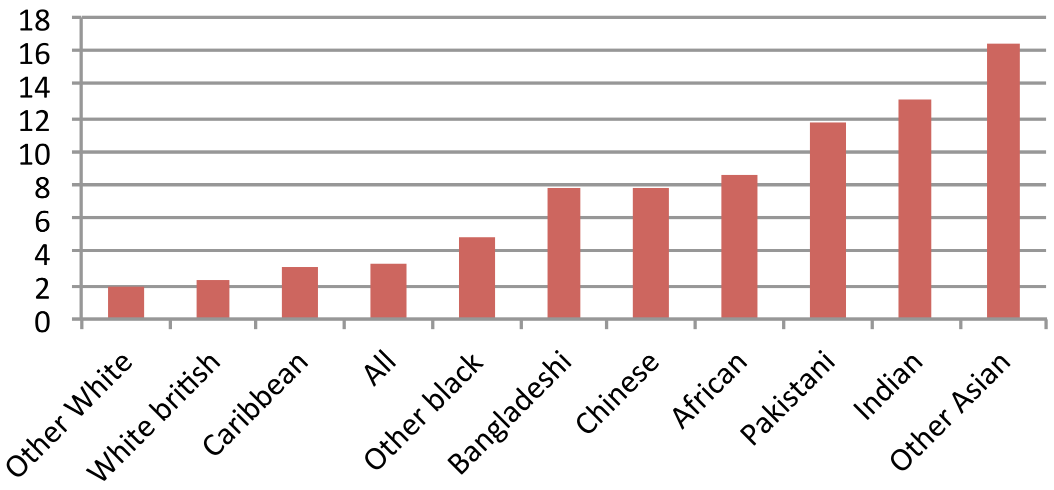
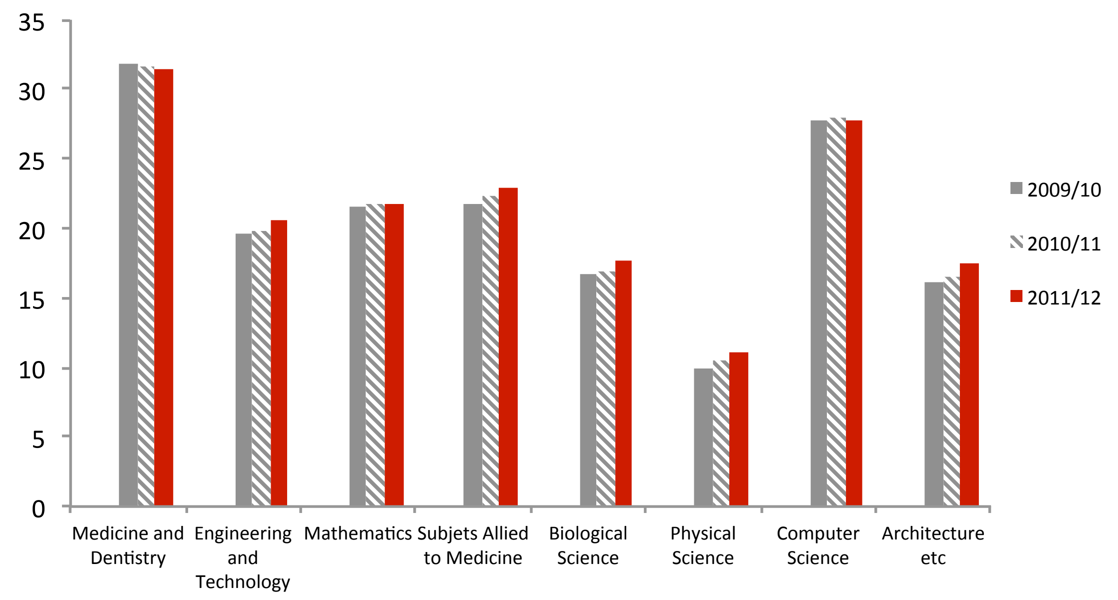


Figure 16 –
Minority ethnic students as percentage of total degree students (selected subjects)

Source: HESA



Some of the money, around £180 million, has been given to schools to allocate as they see fit via a bursary scheme[261].

BME students are more likely to continue their post-16 study and pursue higher education entry qualifications in further education (FE) colleges than at sixth form[262]. Therefore recommendations relating to STEM courses in FE in the section on social disadvantage equally apply here.

ETHNICITY AND HIGHER EDUCATION

Of UK domiciled university students, those from BME backgrounds have a larger representation in higher education than in the general population[263]. Indeed, BME students are more likely than their White counterparts with the same GCSE levels to attend university by the age of 19. This is also true in STEM subjects where in 2011/12, a fifth of all students were from an ethnic minority[264]. However, it should also be noted that several studies have found that BME students are less likely to attend higher-tariff universities[265] or achieve a first class degree than white students[266]. Across all subjects 72% of White students who entered higher education with A-level grades of BBB gained a first or upper second class degree. This compares with 56% for Asian students, and 53% for Black students, entering with the same A-level grades[267]. The Higher Education Race Equality Group (HERAG) is working to improve progression, attainment and graduate level employment rates of BME students across all subjects. The increase in participation at universities across the UK is encouraging, however, there is still much work to be done to address the inequality in attainment at and progression from university[268].

As figure 16 shows, medicine and dentistry and computer science have a higher uptake by BME students and the percentage of BME students is slowly increasing across many other STEM subjects including Physical Science and Engineering and Technology.

There are also gender differences linked to ethnicity to consider. There is evidence that Black women from African or Caribbean backgrounds are more likely to take up STEM subjects than men from the same ethnic groups. In 2009/10, female Caribbean students made up 8% of women in STEM subjects whereas men from the same ethnic group made up only 5% of male STEM students. Female Black African students made up a quarter of the cohort of women in STEM subjects while for men the equivalent figure was 21%[269].

BME students are more likely to take up higher degrees that are taught rather than research based (22% and 16% of first year students respectively)[270]. Across all subjects 13% of academic staff with a known ethnicity are from an ethnic minority, however this includes non-UK nationals[271]. For STEM subjects 94% of UK national physics, chemistry and mathematics academics are white. However, in electrical, electronic and computer engineering only 85% of UK national academic staff are white[272], showing a greater degree of diversity than the average of 92% across all cost centres[273]. In 2010-11, there were significantly higher proportions of UK national academics from a BME background in medicine and dentistry and engineering, technology, building and architecture at 18 and 14% respectively, than the overall proportion of 8%. Of the STEM subject areas, physical sciences had the lowest proportion of BME UK national academics.

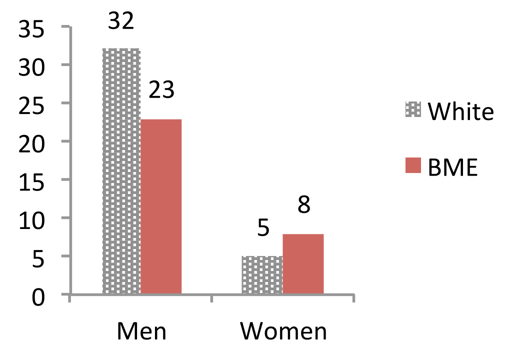
Breaking down the data for physics staff shows it is misleading to make generalisations across all ethnic minority groups – Asian staff make up 1.8 % of Professors and 2.9% of Researchers while making up 6.8% of the population in England and Wales. In contrast, Chinese staff make up 0.7% of the total population but 1.9% of researchers and 2.6% of professors. Black academics account for only 0.2% of professors and 0.4% of researchers despite making up 3.3% of the total population[274]. Although it should be considered that the ethnic make-up of the country is not static and the ethnic diversity of the population has increased over time, this cannot fully account for the low numbers. In fact, unlike other measures, the proportions are so low that the reported figures do not tend to be broken down by both grade and cost centre. It is therefore difficult at present to do meaningful comparisons across disciplines. Across the sciences for all academic staff the numbers do suggest that the proportions of BME staff is buoyed by higher than average numbers of Chinese staff, which masks a lower than average number of Black academics[275].

The Equality Challenge Unit (ECU) commissioned work to look into the experiences of BME staff across disciplines in higher education and found some concerning results around perceptions of and opportunities for BME staff[276]. Further to this the ECU are developing a race equality charter mark to be piloted in a number of universities this year. Application and awarding of the charter mark will work in a similar way to the Athena SWAN award requiring commitment, action and progress in race equality[277]. The sector and government should work with Equality Challenge Unit to ensure that learning from Athena SWAN is transferred in to the development of the new race equality charter mark. This is a welcome step forward and we would urge universities and departments to actively engage once it is developed. University departments should proactively engage with the Equality Challenge Unit's Race Equality Charter Mark when it is launched, using it as a framework to uncover and address any barriers to access and progression for staff and students from an ethnic minority group.

ETHNICITY AND THE STEM WORKFORCE

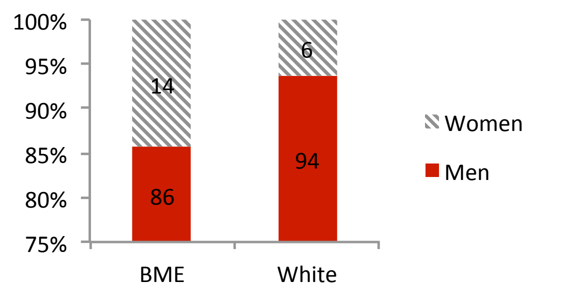
A study by the UKRC showed that although similar proportions of white and BME women obtained undergraduate and postgraduate qualifications in STEM, BME women are more likely to then go on to work in STEM occupations. Interestingly, as shown in figure 17 the reverse trend is seen for men with BME men 28% less likely to work in STEM than White men[278].

Figure 17 –
The proportion of men and women employed in STEM occupations varies by ethnicity[279]



The proportion of all BME women working in STEM occupations is also increasing faster than the proportion of all White women working in STEM occupations. Figure 18 shows how women account for a much higher proportion BME engineers than white engineers. This trend is seen across

Figure 18 –
Percentage of engineering professionals by gender varies by ethnicity[281]



all STEM occupations except health[280]. This could point to cultural and perception based barriers to participation in the STEM workforce, in addition to gender specific barriers, that need to be addressed.

Overall, certain BME groups are more active in STEM subjects than white groups, while individuals from some ethnic groups are still far less likely to study or work in STEM. In many cases ethnicity is unlikely to be the sole reason for the differences between the uptake of STEM courses by BME groups, due to the complex interaction of cultural, socioeconomic, and other factors.

To ensure that progress can be appropriately measured, national monitoring should be undertaken across the workforce, including academia, to provide sophisticated benchmarking on current levels of employment by ethnicity.

ACTIONS: ETHNICITY AND STEM

The sector and government should work with Equality Challenge Unit to ensure that learning from Athena SWAN is transferred in to the development of the new race equality charter mark

University departments should proactively engage with the Equality Challenge Unit's Race Equality Charter Mark when it is launched, using it as a framework to uncover and address any barriers to access and progression for staff and students from an ethnic minority group

To ensure that progress can be appropriately measured, national monitoring should be undertaken across the workforce, including academia, to provide sophisticated benchmarking on current levels of employment by ethnicity

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CASE IS COMMITTED TO IMPROVING ITS OWN DIVERSITY

In our 2008 report, CaSE committed to improving the diversity of its governing bodies within the term of office. Since then, there has been significant improvement in the gender balance of the Board of Directors.

	CaSE staff	Board of Directors	Advisory Council
2008	2/4	2/15	11/47
2014	2/3	7/15	10/40

CaSE will continue to monitor and take action to improve the diversity of its governing bodies. As part of the cross-government compact, CaSE pledge to ensure our events have a diverse range of speakers and panellists with, for instance, no all-male panels. CaSE also commits to continue championing diversity in STEM and monitoring the extent to which diversity is embedded in policy making for STEM.

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