CaSE

Campaign for Science and Engineering

EDUCATION POLICY REVIEW

INSPIRING INNOVATION

Inspiring young people needs:

- A confident and empowered teaching workforce
- Making science and engineering careers inclusive for all young people
- Exploration of innovation through practical, hands-on science

Introduction

The UK is set to increase its public research investment to £22bn by 2024/25, driven by the UK Government's aim to create a more innovative economy and society. It is important that everyone across the country should be able to participate and prosper in a more research-intensive society. This not only means continuing to inspire an increasingly diverse group of people to become scientists and engineers, but also equipping all young people with the skills to take advantage of advances in research and innovation.

It is vital, therefore, that young people can receive a far-reaching and well-rounded science education in school. Primary and secondary schools up and down the UK are under immense pressure to deliver the best outcomes for pupils, which is why they need support from governments and devolved administrations to deliver high quality science education.

Why is STEM education so important?

The UK's science and engineering base is only as strong as the people who work within it. The UK Government's drive to make the UK a 'science superpower' will require a larger pipeline of young people becoming scientists, researchers and technicians. Central to this is providing more opportunities to a greater number of young people, regardless of their background, showing that science and engineering can be a career for everyone across the country.

Children at the age of 7 are already forming opinions on their careers based on factors including race, gender and socio-economic status (1). Disparities in educational attainment are the greatest driver of regional variation in productivity across the UK (2). By improving educational attainment, the UK can also seek to reduce regional inequalities and 'level up' all regions of the country. A broad and balanced science education is not only important to encourage more children to become scientists and engineers but also to increase the science capital of the next generation (3). This is incredibly valuable to the UK Government's aspirations to give all children a fulfilling education and a prosperous future. By learning in a scientific way, children can develop a huge number of hard and soft skills that will be able to help them in their future lives, whatever career they choose. In turn, equipping young people with valuable skills can help the UK move to an increasingly productive and high-value economy. Research from the OECD has shown that investment at every educational level yields positive public economic value (4).

By nature, children are curious and interested in how the world around them works. Every question and new place to explore is in essence an experiment that young people undertake every day. Science education in schools plays an important role in retaining the natural curiosity of children. It is also increasingly difficult to find an aspect of day-to-day life that has not been made possible or enhanced by science and research. Part of the UK Government's drive to secure the UK's place as a 'science superpower' must include making the citizens of the UK feel connected to science, engineering, research and innovation. Starting to create this sense of connection in schools will pay dividends for future generations.

This briefing seeks to set out some of the challenges for science education across the UK. We will also set out a number of recommendations for Government to support the provision of high-quality science education. This document has been compiled with support and guidance from leading experts in the field of science education policy who have helped to inform CaSE's policy positions. Achieving these changes are vital to ensure that current and future generations can contribute to and flourish in a more research-intensive UK.

About CaSE

The Campaign for Science and Engineering (CaSE) is the UK's leading independent advocate for science and engineering. Our mission is to ensure that the UK has the skills, funding and policies to enable science and engineering thrive. We represent over 115 scientific organisations including businesses, universities, professional bodies, and research charities as well as individual scientists and engineers. We are funded entirely by our members and receive no funding from government.

Summary of Recommendations

A confident and empowered teaching workforce

1. Monitor the effectiveness of mentoring and training opportunities for newly qualified teachers
2. Comprehensively review support packages that are offered to teachers to attract applications in disadvantaged areas
3. Fund, develop and implement a system of subject-specific CPD in each nation of the UK
4. Acknowledge the importance of subject-specific CPD in improving quality of teaching of STEM-related subjects. This includes supporting access to opportunities delivered by high-quality CPD providers that meet respective CPD standards in each country.
5. Steps should be taken to entitle all teachers to receive 35 hours of high-quality CPD per year, with at least 50% of this time being dedicated to subject-specific CPD based on the learnings from the Wellcome CPD Challenge
6. Governments should require primary schools to have Science Leaders and mandate they receive dedicated release time to access CPD and time to disseminate their training.

Making science and engineering careers inclusive to all young people

7. Design and implement a careers strategy in England that can deliver high-quality careers advice
8. Expand UK Government and devolved administration funding of careers programmes to ensure provision is available to all schools

Exploration of innovation through practical, hands-on science

9. Ensure that practical work remains a part of assessment in the sciences
10. Review school science technician pay and conditions, considering what policy measures might help to attract and retain science technicians in the future

A confident and empowered teaching workforce

Retention of science teachers

Retention of teachers and staff in secondary schools is a challenge for science education. Prior to the Covid-19 pandemic, data showed a large rise in vacancies for science teachers and rising rate of teachers leaving the profession within five years. Over the last decade, the number of vacancies for science teachers in English secondary schools has increased five-fold from 80 to 378, despite the number of secondary school teachers not increasing significantly over the same period (5). Since the pandemic, however, the relative job security of teaching has led to a surge in applications to initial teacher training and is likely to have led to greater retention of teachers (6).

Historical trends have shown that an increasing number are of teachers leaving the profession within their first five years of teaching. Of teachers starting work in 2009, 74% of the newly qualified cohort remained in the profession, compared with just 67% of those starting in 2014 (7), with science teachers more likely to leave the profession than their peers (8). This is a problem because teachers become more effective, in terms of their ability to improve attainment, as they gain experience on the job (9)(10). Empirical studies have shown that this is particularly the case for science teachers, with those who have been in the profession for five years having a greater impact on pupil attainment when compared with new entrants to teaching (11). This means that where experienced teachers are being replaced, pupil outcomes will tend to fall. There are also concerns over the impact the Covid-19 pandemic has had on the opportunities for trainee teachers to develop their skills in teaching practical work.

Being able to provide opportunities for teachers to further their careers and develop their skills is central to retaining skilled and passionate teachers. Research shows that a common feature of the world's best school education systems is substantial and sustained investment in teachers' professional development (12). Continuing Professional Development (CPD) has been shown to have a significant impact on retention of teachers, particularly those in their first few years of teaching (13). The Early Career Framework in England is being introduced from September 2021 which will provide funding for newly qualified teachers to access high-quality CPD within the first two years and is a welcome development in creating opportunities for teachers to grow (14).

Recommendation:

1. **Monitor the effectiveness of mentoring and training opportunities for newly qualified teachers**

Learning from the Early Career Framework in England, all countries should seek to develop a comprehensive set of opportunities for newly qualified teachers to receive high-quality, and subject-specific, CPD.

Attracting highly-skilled people to teaching

Along with retention of science teachers, attracting new teachers to the profession remains a significant issue. Mathematics and Physics graduates could expect to command higher salaries outside of teaching in England which means it may be more difficult to attract talented graduates in to teaching (15). Evidence shows that these challenges are exacerbated in the most disadvantaged areas, where schools find it particularly difficult to recruit teachers with the right skills (16). Disadvantaged schools in England are also more likely to employ a larger number of less experienced teachers (17).

There have been many efforts from Governments and devolved administrations to address some of these issues. Under the coalition Government that took office in 2010, a £67m package was made available to support recruitment and retraining of teachers in Mathematics and Physics in England (18). It was shown to have a positive, but limited, impact in a report from the National Audit Office (19). In England, university graduates can be offered up to £26,000 to train as a secondary school teacher in Chemistry, Computing, Physics and Mathematics (20), with similar schemes available in Scotland (21) and Wales (22). England recently announced that they will increase starting salaries to £30,000 by September 2022 (23).

While some financial incentives have been shown to have positive but limited impacts, it is important to give more support to teachers to work in disadvantaged areas than just higher salaries. To teach under tough circumstances requires resilience and emotional support, as well as financial incentive. The Sutton Trust, in a survey of 3,000 teachers, showed that a more comprehensive set of measures, including reduced timetables, offer of a substantial promotion and the opportunity to work with a talented teacher who they could learn from would be attractive for teachers to work in an educationally disengaged community (24). Schools in these communities need support from governments and devolved administrations in order to offer a wider package of measures to teachers.

Recommendation:

2 **Comprehensively review support packages that are offered to teachers to attract applications in disadvantaged areas**

Offering support like reduced timetables for teachers will require financial commitments, but supporting strong senior leadership requires only time to implement. Governments should explore how wider measures can help with recruitment of teachers in disadvantaged areas.

Supporting teacher confidence for teaching classroom science

Teachers in primary schools are under pressure to teach a broad curriculum. These teachers in particular need to be generalists and very few come from a scientific or engineering background. As the Wellcome Trust has reported, confidence in teaching science is often influenced by teacher's experience in teaching or through having a science background.

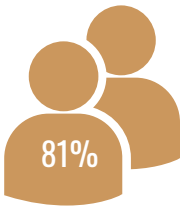
% of primary school teachers that have a qualification at A Level or above in mathematics or science (25)

In a survey conducted across the UK, just over half of primary teachers said they 'agree' or 'strongly agree' they are confident at teaching science (26). The subsequent report found that a lack of confidence can have an impact on the delivery of hands-on experiments and investigations, but access to help and support with teaching science could be found where schools had a dedicated science leader (27).

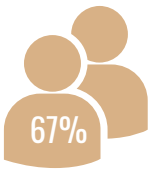
The Wellcome Trust have shown that positive strides are being taken in this space, with the majority of schools now having a science leader and that 61% of science leaders now have dedicated release time to supporting the development of science leaders (28). A randomized controlled trial carried out in 2014 showed that an enthusiastic proficient teacher with nothing more than a C in GSCE Science can undertake CPD and become a very effective subject leader (29).

Despite these positive changes made in primary schools, and despite the fact that science is a core subject, it is often viewed as a lower priority than literacy and numeracy. The same report from the Wellcome Trust showing positive strides in science leaders also showed that only 42% of schools surveyed teach science for two hours or more a week (31). A greater level of accountability over the teaching of science, such as through cluster moderation, could help to raise the profile of science in primary schools (32).

% of primary teachers who received support for science teaching (30)



In schools where the Science Leader has received CPD in the last 12 months



In schools where the Science Leader has not received CPD

This underlines the importance of teachers feeling like they have support for teaching science, and also shows how crucial it is that support is given to science leaders in primary schools. Patchy provision of dedicated support to increase the quality of primary science risk exacerbating disadvantages between pupils in different schools and regions. 90% of teachers in schools with the Primary Science Quality Mark (33) received support compared with 68% of teachers in schools who do not hold the award (34), which provides further indication of patchy provision.

As with retention of teachers, high-quality CPD has been shown to have a significant impact on the quality of learning outcomes for pupils (35). Access to support and expertise is a central barrier to, and enabler of, improvements in providing students with a rounded science education. The value of science lessons in school can be increased by drawing parallels between what students learn in the classroom and the world around them. A lack of confidence in scientific subject matter may hinder the provision of practical science but may

also leave teachers feeling unable to provide real-world examples of what a scientist or an engineer does. Support for teachers is available in providing links between school subjects and real-world examples through schemes such as Primary Futures (36).

Enabling teachers to access more CPD opportunities therefore appears to solve many issues that teachers encounter, however it is not as simple as just offering more opportunities. The Department for Education showed that nine in 10 teachers reported facing barriers to accessing effective CPD (37). The most common barriers include cost and a lack of time to undertake or find high-quality CPD opportunities. The Wellcome Trust CPD Challenge is a pilot running in 40 schools in Yorkshire, working towards providing teachers with a minimum 35 hours of high-quality CPD a year. Early findings from this work showed that almost all staff believe that 35 hours of high-quality, subject-specific CPD is feasible given the right support (38). The pilot has also showed the importance in the role of CPD 'Champions' in schools, alongside the vital importance of additional financial resource in order to access CPD. The second interim report showed that prior to the pandemic, attitudes towards CPD improved through the second year of the challenge and that dedicated cover for release time was crucial to schools completing the challenge (39). Other countries across the UK should engage with and take learnings from Scotland, where teachers are contractually obliged to undertake 35 hours of CPD every year (40).

There are many CPD providers for science and engineering in the UK who provide high quality training opportunities. A culture of professional learning in schools needs several ingredients. School leaders who understand its benefits and know what effective CPD means for their own school's context are crucial to ensure that CPD is championed in schools. All four nations of the UK need a system that recognises and assures high quality CPD and entitles teachers to participate in and have access to high quality and subject specific CPD whether that is externally or internally provided.

Recommendations:

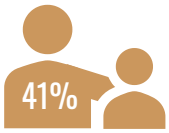
3. **Fund, develop and implement a system of subject-specific CPD in each subject in each nation of the UK**
4. **Acknowledge the importance of subject-specific CPD in improving quality of teaching of STEM-related subjects. This includes supporting access to opportunities delivered by high-quality CPD providers that meet respective CPD standards in each country**
5. **Steps should be taken to entitle all teachers to receive 35 hours of high-quality CPD per year, with at least 50% of this time being dedicated to subject-specific CPD based on the learnings from the Wellcome CPD Challenge**
6. **Governments should require primary schools to have Science Leaders and mandate they receive dedicated release time to access CPD and time to disseminate their training**

Making science and engineering careers inclusive to all young people

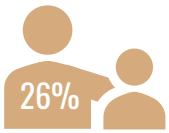
Creating a truly inclusive and diverse science and engineering workforce in the long-term comes from empowering all children to believe that they can become a scientist or engineer. Schools play a crucial role in providing a rounded and real scientific experience for children but formal education is not the only environment influencing young people's decisions of what they would like their future to hold. While some progress has been made in addressing the gender gap (41) within scientific subjects later in school, only 1 in 5 A Level Physics students in 2020 were female (42).

Against a complex backdrop of social factors, becoming a scientist or an engineer can quickly seem impossible for young people. While there is no silver bullet in attracting more young people to a career in research and innovation, the provision of high-quality careers advice can give students an understanding of how they start a career in science or engineering. Providing clear guidance for pupils and linking learning to real-world examples of science and research can also help to counter disadvantages some pupils might experience outside of the classroom.

% of school children who felt encouraged to study STEM subjects (43)



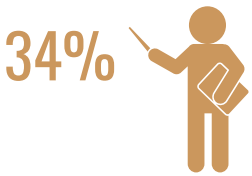
with a parent working in STEM



with parents working in non STEM-related fields

This section is a small summary of our work. More details of our work on diversity and inclusion can be found in our Diversity policy briefing and 2014 report Increasing Diversity in STEM (44).

% of year 7–13 students who said that having a good teacher was a motivation to learn science (45)



Careers advice can be a gateway to opportunity

Without access to personal experience, it is difficult for teachers to explain the diversity of careers in science and engineering and more support should be given to schools to improve this. Providing schools with clear access to resources showcasing the careers of scientists and engineers should be a priority. The Royal Academy of Engineering found that over 600 UK run organisations seek to engage schools with science and engineering (46). Schemes such as STEM Learning's STEM Ambassador programme (47) are a fantastic tool in giving schools not only the chance to invite a professional scientist to talk to pupils, but also draw upon a diverse range of people that can inspire those from all backgrounds that careers in STEM can be for them.

The perception that science is only for the most academically gifted children can often be perpetuated by careers guidance that is often very focused on university routes. Alongside providing links between classroom science and the world around them, a robust and comprehensive careers guidance system is crucial in attracting more students to consider a future in science or engineering.

% of young people aged 11 to 19 who said they would consider a career in engineering (48)

82%

of those who said they knew a lot or quite a lot about the subject

40%

of those who said they knew very little about the subject

The current careers strategy in England ended in December 2020 and as of May 2021 is yet to be replaced. The ease of access to information can have a significant impact on student's decisions. Lack of access to robust careers advice can further increase disadvantages across the UK.

Research from ASPIRES 2 shows that in England, careers provision is 'patterned' around social inequalities and students who are most in need are less likely to receive careers education (49). Again, organisations like STEM Learning provide a range of support for schools to help them adhere to the Gatsby Good Careers Guidance benchmarks (50). The pandemic has thrust scientific advice and evidence into the public eye perhaps more than ever before. Survey data from Engineering UK produced in 2020 showed that secondary school aged children have placed a greater emphasis on 'having a job you are certain you can keep' as a result of the pandemic, as well as feeling like they would like to have a career that is 'having a positive impact on society' (51). Despite these changes, the same data showed over three quarters of students have not taken part in a formal careers activity, such as a careers guidance session, since March 2020.

0.5%

% of schools achieving all 8 Gatsby Good Careers Guidance benchmarks (52)

Robust careers guidance is not the only factor in creating a more inclusive culture for science in schools, but enhancement of resources available to careers leaders in schools can help to show the sheer diversity of careers within science and engineering. Being able to articulate the number of pathways to science and engineering, for example through T-levels, apprenticeships, BTECs and other qualifications can help in showing young people they do not have to go to university to become a scientist, engineer or technician.

Recommendations:

7 **Design and implement a careers strategy in England that can deliver high-quality careers guidance**

England needs a new careers strategy urgently after the previous strategy concluded in 2020. A new strategy should not only be able to give guidance on how to provide equivalent advice for every pupil across the country but also give schools and colleges the resources they need to deliver on the strategy.

8 **Expand UK Government and devolved administration funding of careers programmes to ensure provision is available to all schools**

Access to external organisations to support careers provision should be made available to all schools across the UK. Programmes such as STEM Ambassadors across the country, as well as country-specific agencies such as Careers Hubs in England and Skills Development Scotland, should be given more funding to expand their activities.

Exploration of innovation through practical, hands-on science

Practical science lessons in the classroom brings basic scientific principles to life in a way that can nurture curiosity in young people and allow life-long passion for science to flourish. The development of practical and technical skills are essential in building a future pipeline of scientists, engineers and technicians. They also allow young people to begin to develop skills that will be able to support their future career, whether within a STEM profession or not. Reports such as the 2019 Wellcome Science Education Tracker suggest that while most students want to do more practical work, this is especially the case among disadvantaged students and those least engaged in science (53).

Practical science and the Covid-19 pandemic

The Covid-19 pandemic has caused a significant shift in the way in which children have been asked to learn and how teachers have been asked to teach. One aspect of science education most acutely affected is practical science – the ability for students to interact and test their own hypotheses. A 2020 report from the Association for Science Education surveyed science teachers and science technicians looking at how schools have responded to the challenges posed by virtual learning and social distancing in schools (54).

The findings of the report were concerning, particularly for the short term. Almost 60% of respondents (both science leaders and teachers) were not satisfied with their school or college provision for practical work during lockdown. Schools and colleges anticipated a big reduction in the frequency of practical science taught from September 2020, with respondents estimating it was likely that 20% of GCSE and A Level classes would have no practical science at all. In addition to the logistical challenges of carrying out practical science during the pandemic, nearly 90% of respondents were concerned about the pressure to catch up on missed content during the first lockdown period in from March 2020, with likely knock-on effects on the amount of time that would be spent on activities such as practical work and classroom discussion. The ASE have made a number of recommendations for how schools can amend their practices in order to still meet the Gatsby Good Practical Science benchmarks (55).

Recommendation:

9 **Ensure that practical work remains a part of assessment in the sciences**

The Covid-19 pandemic has caused significant issues for practical science. Governments must ensure that a requirement to carry out practical science returns to the assessable curriculum as early as it is possible and safe to do so.

While the Covid-19 related challenges for delivering practical work apply to students of all ages, there are particular issues for those in examination years. In England, both GCSE and A-Level courses include 'required practicals', with schools being required to confirm that they have enabled their students to do the full range of specified practical work. Due to the impact of the pandemic, it has been agreed that for summer 2021, students can study the required practical activities through the use of demonstrations and simulations if it is not possible for them to carry out all of the practical activities. However, this must not be a long term solution and Governments must ensure that the requirement for students to carry out hands-on practical science returns as early as it is possible and safe to do so.

Improving recognition and progression for science technicians

Equally important to the provision of practical science are school science technicians, an often undervalued part of the education workforce. A survey from 2016 showed that 72% of school technicians were over the age of 40 (56), meaning that the majority of science technicians will be set to leave the profession in the next 20 years. The survey also highlights concerns in attracting people to the profession if the role is undervalued and continues to offer little career progression, with two-thirds of the then technician workforce feeling there were no opportunities for development (57). The average number of FTE science technicians per school has fallen by 16 per cent since 2011/12 (58). Additionally, schools with a less affluent pupil intake tend to have less technician support than those with a more affluent intake (59). Failure to attract and retain technicians, threatens the availability and quality of practical science in schools.

Recommendation:

10 **The Government should review science technician pay and conditions, considering what policy measures might help to attract and retain science technicians in the future**

Next steps

CaSE works towards creating the best environment for research and innovation in the UK, not only making the UK the best place to do research but also thinking about how everyone in the UK can benefit from a thriving, world-leading science and engineering sector. Embedding science and engineering into the lives of young people is the first step in helping to create equitable opportunities to play a major role in a more innovative UK. We will continue to work with our members and collaborators across the STEM education landscape to give all young people a high-quality science education.

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