THE ROYAL SOCIETY

Policy briefing on teachers of the sciences

Recruitment, retention and development

There are too few specialist science teachers for England's burgeoning secondary school pupil population. However, science (together with English and mathematics) is a statutory core subject of study for all 5 – 16-year-old pupils in England[1]. The National Curriculum recognises that studying science is essential 'for understanding the world' and is 'vital to the world's future prosperity'[2].

Since 'science' in schools encompasses the disciplines of biology, chemistry and physics, it is important to recognise this distinction in relation to teaching, because fully trained physics, chemistry and biology teachers each possess a different corpus of scientific and pedagogical content knowledge. In the rest of this document, the term 'sciences' is generally preferred, except where it would be unhelpful to correct the vernacular.

There have been persistent shortages of teachers of the sciences for many years, particularly in chemistry and physics[3]. This continuing unmet demand is set to intensify since pupil numbers in secondary state-funded schools are due to rise by 224,000 (or 7.5%) between 2020 and 2024[4].

This policy briefing draws on a range of sources to provide insights into the sciences teaching workforce in England's state secondary schools. It reviews the latest available data on teacher recruitment and retention, and teachers' access to continuing professional development, and it highlights key areas for action to enhance our understanding of, and strengthen, the sciences teaching workforce.

Key messages

- There is a continuing chronic shortage of science teachers, particularly those with specialist backgrounds in chemistry and physics, and projected pupil increases will place additional strain on schools and on those who teach the sciences.
- Pupils attending schools in socio-economically deprived areas are less likely to be taught physics and chemistry by teachers with a specialist background in these disciplines.
- Teacher retention in the sciences is poor, compounding the consistent failure to attract sufficient recruits into teacher training (with chemistry and physics being affected in particular).
- Subject-specific professional development is essential to retaining teachers of the sciences, and school leadership teams need to ensure and encourage their staff to access the professional development opportunities provided by STEM Learning and the professional and learned scientific bodies.
- In the light of the increasing demand for flexible working, school leadership teams should explore mechanisms such as braided careers, which enable people to work part-time as teachers and part-time in other employment) and sympathetic timetabling (where newly qualified teachers teach only their specialist subject), in order to attract and retain specialist science teachers.
- There is a need for better subject-specific teacher supply data that provide an enriched picture of how teachers with specialist backgrounds in the sciences are deployed.
- There is a need to learn from successful initiatives to boost science teacher recruitment and retention.

Teacher recruitment

There is a chronic shortage of chemistry and physics teachers, and in recent years the recruitment targets for biology teachers have also not always been met[5].

Secondary schools are struggling to recruit newly qualified teachers of the sciences. Although recruitment to teacher training in biology, chemistry and physics is now unrestricted[6], and will remain so for the foreseeable future[7], the recruitment targets in physics and chemistry have been missed in each of the last five years[8]. These data show that the situation is particularly acute in physics, where the failure to meet the recruitment target has steadily worsened during this period, with just 43% of the desired number of graduates being recruited into physics teacher training in 2019/20.

A range of factors is likely to be responsible for these continuing shortfalls. While each of the sciences has its own particular needs and challenges, there are some that are common to all. For instance, as a graduate profession, teaching must compete with many other sectors of employment to attract talent; and the salary differentials between teaching and other occupations are greatest in the physical sciences (and mathematics and computing) where science teacher shortages are greatest[9]. There is evidence to suggest that these continuing shortages are likely to be informed by wider negative perceptions of teaching that may well be deterring graduates from entering the profession[10, 11, 12].

The science teacher workforce

According to the Department for Education, the numbers of additional science-discipline-specific secondary teachers required to teach the hours of lessons that are currently taught by non-specialist[13] teachers are: physics, 1,700; chemistry, 1,400; and biology, 600[14]. This does not include a further 1,800 biology, chemistry or physics teachers required to teach combined/general science or other science. Across the country, just 50% of physics teachers have a relevant degree, compared with 57% of chemistry teachers and 75% of biology teachers[15], so the scale of the challenge is evident.

Although the percentage of biology teachers is comparatively higher, more detailed information on their deployment is lacking, and there are concerns that out-of-specialist-discipline teaching (eg biology teachers being deployed to teach physics) may be contributing to poor rates of retention[16], and reduce the quality of pupils' learning.

Science teachers with a relevant degree are unevenly distributed across the English regions and local authorities, with shortages being especially acute in economically deprived areas. For instance, while 40 – 50% of physics teachers in London hold a relevant degree, just 17% of physics teachers in schools in areas of high deprivation outside London do so[17].

Further, pupils attending secondary schools located in areas of high social disadvantage are particularly at risk of not being taught by science teachers with a degree in the science discipline they are teaching[18].

Compared with pupils in more advantaged circumstances, key stage 4 pupils in less advantaged circumstances are 14% less likely to be taught chemistry by a chemistry specialist, and 21% less likely to be taught physics by a physics specialist[19].

Schools are having to make difficult decisions regarding the deployment of their teachers. New research shows that the time schools allocate to teaching 'science', and the ways in which this is timetabled, is affected by the disciplinary expertise of their teaching staff[20].

Teacher retention

Teachers of the sciences are more likely to leave the profession than teachers of most other subjects[21]. Poor rates of teacher retention effectively intensify the pressure on recruitment into teacher training and disrupt children's education. Further there is evidence that pupils who have experienced a change of science teacher are less likely to be taught the sciences by subject-specialists[22].

Attrition among early career science teachers is also comparatively high, wastage that exacerbates the high costs of teacher training. From 2010 onwards, the percentages of newly qualified teachers of chemistry and physics continuing in teaching three years post-qualification have decreased (from over 70% to less than 67%)[23]. A very similar rate of decrease has been recorded for mathematics teachers.

Longitudinal data covering the past seven years show rates of leaving the profession among qualified teachers have increased and are among the highest for the sciences, and particularly physics teachers[24].

Professional development

Science teachers are scientists as well as being teachers. Subject-specific professional development is essential for science teachers throughout their careers, allowing them to engage with their subject, and research has shown that it can boost teacher retention[25].

Increasing numbers of teachers have been shown to benefit from participating in subject-specific professional development, and evidence clearly shows that this can improve science teacher retention and the quality of science education[26]. Data from STEM Learning (the UK's largest provider of professional development for science teachers) indicate an increase in teacher engagement with its ENTHUSE programme and/or Network programme from 10,000 in 2013/14 to more than 15,000 in 2017/18, with the number of hours of each of primary, physics, chemistry and biology professional development increasing substantially over the same period[27].

Similarly, demand for professional development activities offered by the Institute of Physics and the Royal Society of Chemistry has also risen in recent years[28]. An evaluation of a series of supply and upskilling interventions aimed at physics (and mathematics) teachers suggests some are more successful than others, with paid internships and Teacher Subject Specialist Training (TSST) courses being most effective[29].

However, teachers' access to professional development has reduced in response to the squeeze on school funding[30].

Areas for action

Since teachers of the sciences may teach other subjects, access to more detailed data is required to understand how many there are. An in-depth understanding of the supply of teachers of the sciences could then be used to pilot targeted initiatives designed to improve the health of science education in secondary schools.

Better discipline-specific teacher supply data

In order to plan effectively for the future, a clearer picture of the workforce is required. The Teacher Supply Model projections are based on an assessment of the amount of time that is spent teaching each discipline[31]. However, this model is not a true reflection of teacher supply in the sciences. Reliable modelling would require accurately assessing the numbers of teachers in the system that are qualified to teach biology, chemistry or physics (and that are teaching one or more of these subjects).

Consistency and rigour in discipline-specific teacher training in England

There are several pathways to gaining Qualified Teacher Status (QTS), with schools rather than higher education institutions now being predominantly responsible for teacher training[32]. There is a need to ensure the wide range of training routes available provide comparable, high quality, training for trainee teachers of the sciences[33].

Learning from initiatives to boost teacher recruitment

The Government has invested substantially in bursaries designed to attract suitably qualified graduates into teacher training[34], but there is no evidence that bursaries and scholarships in the sciences have led to improved educational performance[35]. In fact, data for 2009/10 – 2015/16 show that bursary holders in chemistry, which attract higher awards than most other subjects, were among the poorest in achieving QTS[36].

The effectiveness of the bursaries in recruiting suitable candidates and their ability to incentivise trainees to complete their training need to be studied.

The Government has recently committed to introducing phased bursaries, with payments being staggered over three years in order to aid retention and weighted such that they are higher for teachers working in more challenging schools[37].

Informing strategies to boost teacher recruitment and/or retention

There is a need to understand the reasons why too few graduates are attracted to train to become science teachers, and the high level of attrition from the profession at an early stage of those who do successfully complete their training.

In order to improve retention, it may also be worth exploring whether concerns felt more widely in the profession particularly affect science teachers. It is reasonable to expect that the extent to which individual schools and their teachers have access to well-equipped laboratories, technicians and other teaching resources will affect the likelihood that science teachers remain in the classroom.

Concerns about high teacher workload[38], perceived as a prime cause of low retention, and capacity to undertake experimental science (including experiments that less confident teachers would otherwise avoid) could be ameliorated by:

- investment in (including training) and valuing of science technicians, recognising the vital role they play in developing pupils' practical skills and supporting good science teaching[39]; and
- ensuring all schools and their teachers have access to well-equipped laboratories, good lesson plans and teaching resources (eg textbooks).

In addition, there is a need to follow up recent analysis of the OECD's Teaching and Learning International Survey (TALIS) data, which suggests that low levels of self-efficacy (teachers' belief in their own abilities) may be particularly associated with especially low levels of retention among teachers of the sciences (and of computing and mathematics)[40].

Concerns about teachers' readiness to teach the sciences need to be tackled by:

- enabling them to access professional development provided by STEM Learning and the professional and learned scientific bodies; and
- exploration of the effect on teachers' self-efficacy and impact on teacher retention of examination performance.

Strategies to boost teacher recruitment and widen retention

A reduced focus on high-stakes accountability measures based on testing, and in their place more coherent methods are needed to assess the performance of students, teachers, head teachers and principals, and the overall performance of schools and colleges[41]. The Society believes that schools should provide a connected and coherent curriculum, including elements beyond those directly measured by the assessment system.

School leadership teams have a key role to play in supporting and valuing their teachers, ensuring they can access the professional development they need[42]. Evidence shows that teachers who undertake subject-related continuing professional development are more likely to stay in the classroom for longer[43]. Subject specific continuing professional development for all teachers of the sciences is essential so that they can refresh their subject-specialist knowledge and keep up-to-date with the evolving evidence base. This is especially true in the sciences, where the pace at which new knowledge and understanding emerge has implications for school curricula.

Braided careers in teaching, offering flexible working for those who would like to teach part-time and work part-time in industry or a research institution, could help increase the numbers of science teachers, further enhance their professional status and encourage more of them to stay in teaching for longer[44].

The Government's recently launched *Teacher recruitment and retention strategy* includes commitments to providing early career teachers with a fully funded package of support for two years (the Early Career Framework), and creating an extended range of National Professional Qualifications[45]. The success of the Early Career Framework will depend in large part on ensuring that new resources are developed with the help and endorsement of biology, chemistry and physics specialist teachers. Newly qualified teachers of these subjects need to be supported by discipline-specific mentors and timetabling that maximises the time they spend teaching their specialist subject.

With many schools currently requiring biology teachers to teach chemistry and physics, more resources need to be invested in upskilling biology teachers so that they can confidently adapt to teaching the chemistry and physics demands of the National Curriculum. This is because biology teachers are most numerous among science teachers. However, evidence suggests that early career teachers, in particular, those that teach multiple subjects, including ones they have not been trained to teach, are at particular risk of leaving the profession, so this is not a desirable strategy for the longer-term[46].

The Government has also recently launched a pilot initiative in the North East and Yorkshire and the Humber regions, offering retention payments of £2,000 to eligible early career physics (and mathematics) specialist teachers in 2019 – 20 and 2020 – 21[47]. It should monitor the impact of this initiative, with a view to extending these payments to physics and chemistry teachers nation-wide, should it prove to be effective.

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