



A 'state of the nation' report
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The UK's science and mathematics teaching workforce

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A healthy, sustainable and progressive knowledge economy depends on inspiring new generations of scientists and engineers. Achieving these ends depends heavily on there being a similarly vigorous population of good quality science and mathematics teachers. The Government has committed to providing long-term support for UK science and innovation, including setting a number of challenging education targets for England, but concerns have been growing for years that there are inadequate numbers of science and mathematics teachers, and that poor rates of recruitment and retention and a high level of retirement are exacerbating the situation. This first 'state of the nation' report is designed to establish the precise nature of the situation not only in England but across the UK, in order to understand fully the true extent of the challenges we face and to establish a solid basis upon which to build purposeful policy. Therefore, while the report provides a compendium of vital information on our workforce, given the considerable gaps in the evidence base it highlights, it is geared towards achieving change. Consequently, we will be monitoring the extent to which others have taken forward the various recommendations and expect to update this report in future.

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Physical Secretary and Vice-President of the Royal Society



The challenge of fostering new generations of scientists and mathematicians is a fundamental concern for the Royal Society, Government and UK industry. We recognise that teachers of science and mathematics at all educational levels within our schools and colleges have a crucial role to play in achieving this end. So it is astonishing to discover, as this report reveals, that there is no universally accepted understanding across the UK as to what constitutes a specialist science or mathematics teacher, and that data on such key indicators as workforce size, supply and demand are invariably patchy in terms of their consistency, quality and reliability. I am, therefore, extremely grateful to Julia Higgins and David Montagu in taking the lead on this project, and to the whole working group in contributing to this substantial review. I very much hope that this report proves helpful to all organisations and individuals who are concerned to ensure that the UK's education is of the highest quality.

This Royal Society project is supported by SCORE (Science Community Representing Education). SCORE is a partnership between the Association for Science Education, the Biosciences Federation, the Institute of Biology, the Institute of Physics, the Royal Society, the Royal Society of Chemistry and the Science Council. SCORE aims to improve science education in UK schools and colleges by harnessing the expertise, influence and resources of key independent organisations to support the development and implementation of effective education policy and projects.

Executive summary

The number, quality and deployment of science and mathematics teachers in our schools and colleges are matters of vital importance to the UK. They have major implications for: the quality of science and mathematics education; young people's intellectual development and their ability to make a responsible contribution to a world that increasingly depends on scientific knowledge for solutions to its many and varied problems; fostering new cadres of professional scientists, engineers and science and mathematics teachers; and the UK's status as a leading knowledge economy.

By using the most reliable data available, this report examines:

- the size of the UK's science and mathematics teaching workforce;
- the extent to which this workforce is populated by 'specialists';
- the sources and numbers of new recruits to the profession;
- retention within, and attrition from, teaching;
- the demand for science and mathematics teachers;
- recruitment targets and workforce planning.

The report is grounded in data that are in the public domain. Included are some data that are not routinely made available by the agencies responsible for collecting them. In addition to providing an overview of data available on the science and mathematics teaching workforce across the UK, the report offers a critique of their adequacy.

We very much hope that this assessment of workforce data will promote constructive policy-making throughout the UK that will help create a sustainable community of high-quality science and mathematics teachers sufficient to provide for the needs of all schools and colleges.

1 Main conclusions

1.1 Governmental statistics do not capture fully the acute problems faced by schools and colleges in maintaining a strong science and mathematics teaching workforce. The quality of the data available is patchy and it is very difficult to establish a complete and clear picture of the situation in any of the four nations that comprise the UK, let alone make meaningful comparisons across these nations.

1.2 No accurate estimate of the population of science and mathematics teachers in the UK exists, nor can this be obtained from the available data. This is because: (i) there is no consensus concerning how a 'specialist' science or mathematics teacher should be defined; (ii) the numbers of 'specialist' science and mathematics teachers in the primary sector are unknown because specialists at this level are not recognised; (iii) scarcely any data are available on the specialist science and mathematics teaching workforce within the further education and independent sectors. **Accurate workforce planning requires that these issues be properly and urgently addressed.**

1.3 Across, and within, each of the four nations of the UK there are inadequacies in the type and quality of data relating to recruitment, retention and attrition of science and mathematics teachers. In particular, the lack of disaggregated data across all science subjects frustrates attempts to understand the discipline-specific expertise entering, continuing in and exiting the profession. Nonetheless it is evident that a significant proportion of those who are accepted for, or begin, initial teacher training courses either fail to complete them or, for reasons that are not entirely clear, do not pursue teaching once they have qualified.

1.4 Counts of published advertisements and additional considerations show that schools face a much tougher challenge in recruiting appropriate science and mathematics teachers than is reflected in the official counts of vacancies. This is particularly concerning given the Government's commitment to provide for all 14 year olds in England who perform well in their Key Stage 3 tests a new entitlement to study separate GCSE courses in biology, chemistry and physics, and its desire to see greater numbers of students progress to post-16 studies in science and mathematics.

1.5 The Government has consistently missed its targets for recruitment into initial teacher training courses in science and mathematics. Furthermore, the targets it has set itself for mathematics and science teacher recruitment do not appear to be backed by adequate workforce planning.

There is much that needs to be done in terms of gaining a sustainable, accurate and detailed picture of the science and mathematics teaching workforce. While this prevents us from being able to say precisely how many science and mathematics teachers are actually needed, the evidence available suggests that there is a serious shortage of these teachers particularly in England, and perhaps increasingly across the UK as a whole.

Given this situation, and the fact that informed and rational policy-making depends upon there being an extensive and high-quality bank of underlying data, we make the following overarching recommendations. A full list of recommendations appears in chapter 10.

2 Overarching recommendations

2.1 Define what is meant by the term 'specialist' science/mathematics teacher

The Government, Devolved Administrations and the wider community should agree on definitions for specialist science and mathematics teachers. These definitions must be unambiguous so as to ensure their application accurately informs future surveys and studies. (Chapter 3)

2.2 Better assess supply of, and demand for, science and mathematics teachers

The Government and the Devolved Administrations should employ a much more rigorous and systematic approach to tracking the demand for science and mathematics teachers across the UK. (Chapter 7)

The Department for Children, Schools and Families should, as a matter of urgency, update its Teacher Supply Model, consult with the science and mathematics education communities over the setting of recruitment targets into initial teacher training, and explain publicly the basis of its target-setting. (Chapter 9)

2.3 Improve access to science and mathematics initial teacher training courses and support for qualified teachers throughout their teaching careers

Higher education institutions that offer secondary PGCE courses and which have strong reputations in science should be encouraged to offer PGCE courses in the separate sciences or in other ways support the training and development of teachers in these subjects. (Chapter 4)

Creative strategies aimed at retaining science and mathematics teachers, and at supporting their return to the profession, need to be devised alongside a greater understanding of the reasons why teachers leave the profession. (Chapter 5)

The Department for Children, Schools and Families should redouble its efforts to increase progression in science beyond GCSE and, in particular, uptake of the physical sciences and mathematics at university in order to help ensure that there are adequate numbers of teachers available to provide specialist teaching in these subjects in all schools. (Chapter 9)

2.4 Improve quality-control procedures and record-keeping of science and mathematics teachers' careers

The Government, the Devolved Administrations of the UK and their agencies (particularly the General Teaching Councils and Lifelong Learning UK) should agree shared guidelines and protocols for regular collection of data on the science and mathematics teaching workforce throughout the maintained school, independent and learning and skills sectors. (Chapter 3)

The Government, the Devolved Administrations of the UK and their agencies should maintain much more detailed and comparable records on the retention of trainee, newly qualified and more experienced science and mathematics teachers and the factors affecting their retention. (Chapter 5)

2.5 Research needs

Research is needed into:

- i. the impact of subject specialism/subject knowledge in relation to teacher confidence and competence and the engagement and subsequent achievement of young people. (Chapter 3)
- ii. the number, deployment and qualifications of science and mathematics coordinators in primary (including preparatory) schools, and their impact on learning and attainment. (Chapter 3)
- iii. the number, deployment and contribution of overseas teachers to UK science and mathematics education. (Chapter 4)
- iv. the provision and popularity of combined science PGCE courses in England and Wales, including the reasons why providers offer this PGCE, the qualifications of those taking this PGCE and the reasons why trainees opt to take a PGCE in combined science in preference to a specialist science PGCE course. (Chapter 5)
- v. assessing differences in the quality of newly qualified science and mathematics teachers from different initial teacher training providers. (Chapter 5)
- vi. the movement of science and mathematics teachers between educational levels and sectors, regionally and across the UK nations, and particularly into how variations in teacher supply affect individual schools, especially those in challenging circumstances. (Chapter 5)

10 Future work

Many of the issues highlighted in this first 'state of the nation' report will be revisited in future updates. In the meantime, the Royal Society will continue to monitor workforce data and reiterate or raise new concerns if, and as, these arise, including where appropriate in other reports in the 'state of the nation' series. The Society is keen to play its part in ensuring that the recommendations from this report (reproduced in full below) are acted upon, and will be monitoring progress in respect to these in future.

Chapter 3. Estimating the size of the active science and mathematics teaching workforce in the UK

Recommendation 3.1

Governments and the wider community should agree on definitions for subject specialist teachers. These definitions must be unambiguous so as to ensure their application accurately informs future surveys and studies, and should be used to monitor more effectively the quality of teaching and pupil engagement and achievement. Equally, it must be recognised that subject specialism may be gained in a variety of ways, and that this must be taken account of in assessing prospective teacher trainees who are changing careers and/or have non-traditional qualifications and/or are undergoing appropriate continuing professional development.

Recommendation 3.2

The UK governments, General Teaching Councils and Lifelong Learning UK should agree shared guidelines and protocols for regular collection of data on the science and mathematics teaching workforce, which should also include accounts of the gender balance among such teachers. The Independent Schools Council should be involved in these discussions in order to ensure that the independent sector is included in future assessments of the totality of the school workforce.

Recommendation 3.3

The General Teaching Councils should regularly collect information about the subject specialisms and degree subjects of all registered teachers, in accordance with the universally applied definitions called for in Recommendation 3.1. They should maintain and make available up-to-date records of this information in an agreed, common format.

Recommendation 3.4

Further research is needed into the impact of subject specialism/subject knowledge in relation to teacher confidence and competence and the engagement and subsequent achievement of young people. Ofsted, which has collected such information in the past, should be a key partner in this work.

Recommendation 3.5

Further research is needed into the number, deployment and qualifications of science and mathematics coordinators in primary schools, and their impact on learning and attainment.

Chapter 4. Supply of newly qualified science and mathematics teachers across the UK

Recommendation 4.1

The Training and Development Agency for Schools and the Department for Children, Schools and Families should produce disaggregated data on the specialisms of people who are undertaking science- and mathematics-focused employment-based training.

Recommendation 4.2

There is need for ongoing research into the increasing provision and uptake of the combined science PGCE in England and Wales, the impact it is having on the quality of science teaching in the sciences at GCSE level, and the overall availability of teachers specialising in the separate sciences.

Recommendation 4.3

In order to help maximise the opportunities available to would-be science and mathematics teachers, those higher education institutions with a strong reputation in science and/or mathematics should be encouraged to offer PGCE courses in the separate sciences and/or mathematics, or otherwise support the training and development of teachers in these subjects.

Recommendation 4.4

There is a need for more precise records on the science specialisms of overseas trained teachers to be kept, as the numbers of these teachers are a barometer of schools' needs. Practically, this might best be done by the General Teaching Councils regularly collecting records from schools. Given the variable amounts of time that these teachers may be domiciled in the UK, it is equally important to try to measure their deployment in schools, their retention in schools and in the UK, and to determine their impact on the quality of teaching and learning.

Recommendation 4.5

Research is needed into understanding what relationship there may be between the gender structure of the workforce and male and female subject choice pre- and post-16.

Recommendation 5.1

Ongoing research is needed into the variation of subject knowledge among those gaining qualified teacher status in the sciences and mathematics from different initial teacher training providers. This would provide valuable insight into the challenges teachers face in their induction year and beyond. In particular, such research would have implications for the range of continuing professional development that needs to be available to ensure that subject knowledge is maintained, developed and applied. In addition, it may be more helpful for newly qualified teachers and schools if providers gave more information about the subject knowledge and skills of their new completers.

Recommendation 5.2

The UK governments should maintain much more detailed and comparable records on the retention and drop-out by gender and by region of science and mathematics teacher trainees and newly qualified and more experienced science (by specialism) and mathematics teachers.

Recommendation 5.3

More research is needed into teacher turnover and flow regionally, from country to country and across sectors, there being a need to focus this at the level of local authorities and even, perhaps, that of individual schools. In particular, it is necessary to explore the movement of science and mathematics teachers into and out of the independent sector.

Recommendation 5.4

Creative strategies aimed at retaining science and mathematics teachers, or supporting their return to the profession, need to be devised alongside a greater understanding of the reasons why teachers decide to leave the profession. The National Network of Science Learning Centres and the National Centre for Excellence in the Teaching of Mathematics should work together to develop such strategies. It is vital that these organisations are given the necessary funding to enable them to undertake this work.

Chapter 6. Retirement of science and mathematics teachers across the UK

Recommendation 6.1

The Training and Development Agency for Schools (TDA) should keep an ongoing account of the subject specialisms, qualifications and gender of teacher returners, and research should be undertaken by the TDA and Department for Children, Schools and Families into the reasons behind decisions to leave, and to return to the profession.

Recommendation 6.2

The UK governments, or their agencies, should keep and maintain comparable records on the age profiles of science and mathematics teachers in schools and colleges. It is important that the former be disaggregated by specialism.

Recommendation 6.3

The Association for Science Education, the learned and professional bodies and the mathematical associations should continue to work with the National Network of Science Learning Centres and the National Centre for Excellence in the Teaching of Mathematics to provide more imaginative support to science and mathematics teachers to help maximise the length of their teaching careers.

Chapter 7. Demand in the science and mathematics teaching workforce

Recommendation 7.1

The UK governments must employ a much more rigorous and systematic approach to tracking the demand for science and mathematics teachers across the UK. Equally, it is important for them to gain a firmer grip on the extent to which schools are able to attract the science and mathematics specialists they need, rather than having to resort to alternative means to fill vacancies in these subjects.

Recommendation 9.1

The Department for Children, Schools and Families should, as a matter of urgency, update its Teacher Supply Model.

Recommendation 9.2

The Department for Children, Schools and Families should consult with the science and mathematics education communities over the setting of new recruitment targets into initial teacher training, and it should explain publicly the basis of its target-setting.

Recommendation 9.3

The Department for Children, Schools and Families should step up its efforts to increase recruitment in the physical sciences and mathematics, to ensure that there are adequate numbers of teachers to provide specialist teaching in these subjects wherever and whenever it is needed, so that, for instance, teachers may take full advantage of the professional development opportunities that are available to them.

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