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A 'state of the nation' report

2007

The UK's science and mathematics teaching workforce

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Professor Dame Julia Higgins DBE FRS
Chair of the 'State of the nation' Reports Working Group

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.

Professor Martin Taylor FRS
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.

Preface

This is the first in a series of reports from the Royal Society aimed at monitoring and helping to improve the quality of science and mathematics education in the UK. This series of reports is intended to support efforts to increase the quality of UK science and mathematics education, particularly participation and progression in science and mathematics by, (i) identifying and assessing significant trends in participation and performance across 5–19 education; (ii) evaluating the strength of the evidence base upon which future educational policy is likely to be made; (iii) highlighting where improvements to the content and range of the evidence base could facilitate responsible policy making; (iv) identifying areas where new or further research is needed; and (v) recommending new policy initiatives.

In order to fulfil these aims, we have:

i. identified, gathered and analysed key data on the workforce;

ii. evaluated the quality of these data and made recommendations as to where the content, range and methodology of their collection could be improved; and

iii. interpreted our findings in the context of current policy and practice so that they are relevant to and usable by a range of policy-makers and policy-influencers.

In fulfilling these aims, it is hoped this series of reports will become established as a key reference for the science and science education community and policy-makers and opinion-formers.

We intend to revisit the topic of this report at regular intervals over the years in order to maintain an up-to-date picture of the science and mathematics teaching workforce in the UK, and help support all those who, working together, can take positive action where it is required.

Feedback and further information

The Royal Society welcomes comments on the evidence and recommendations presented in this report.

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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 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)

1 Introduction

1.1 Why are science and mathematics teachers important?

The importance of a good quality science and mathematics education for all is widely acknowledged as fundamental to an individual's education. The skills, knowledge and understanding that come from learning and enjoying science and mathematics at school and college prepare young people for jobs in a demanding workplace and life in the modern world. With the guidance of a good teacher, these subjects become opportunities for young people to explore and wonder at the world around them and to discover the rich heritage from centuries of global experimentation and adventure.

Teachers are generally the greatest influence on a young person's personal and intellectual development other than parents or guardians. In science and mathematics, subjects that parents often claim to find difficult and which tend to be less positively represented in youth culture than some other subjects, the role of the teacher becomes even more critical.

1.2 What makes a good science or mathematics teacher?

Classroom teachers need a wealth of professional and personal attributes, knowledge and skills to do their jobs well, and to work within their wider team. Enthusiasm for their subject, the ability to explain concepts and the creativity to make them relevant need to be backed up with skills in communication, class management and resource management as well as delivered within the context of a relationship with each and every one of their pupils. A good teacher has the ability to move their pupils forward in life by passing on their own knowledge, skills and passion for learning. An excellent teacher – one that is credited with inspiring life-changing decisions and is remembered forever – has an extra dimension of dynamism, dedication and imagination that make for the most stimulating lessons and effective engagement of young people.

How do we know if we have, and will continue to have, enough good science and mathematics teachers? This is a complex question of quantity and quality, requiring the UK to assess demand, calculate supply and estimate attrition. The Government's response is to model the teaching workforce in the simplest and most effective way, and choose measurable and representative indicators of quality.

For the purposes of this report we largely focus on subject knowledge as one of the critical indicators of science and mathematics teacher quality as we believe that those teaching these subjects cannot do so without sufficient subject knowledge. However advanced their pedagogical skills, their empathy with young people and their commitment to pupil well-being, teachers will not perform well if they do not feel confident about and interested in the subject they are teaching. In this report we consider science teachers as a composite grouping or, where appropriate, as disciplinary specialists.

1.3 What is the purpose of this report?

In recent years it has become more difficult to recruit and retain good teachers, particularly in certain 'shortage' subjects. For at least the past 25 years, that is to say the span of a whole human generation, concerns over the numbers of proficient science and mathematics teachers have consistently and repeatedly been voiced by a range of organisations and reported by the media.[1] A plethora of papers, research studies and reports has been published drawing attention to different aspects

1 For the purposes of this report, 'science' is defined as biology, chemistry and physics.

of this issue, significant among these being those produced by government-instituted inquiries led by Cockcroft (1982),[2] Roberts (2002)[3] and Smith (2004).[4]

1.4 Notes on the data

Data for this report were collected between March and September 2007. Throughout this report, use has been made of the most reliable data that are freely available to the public. The electronic appendix to this report (available at http://www.royalsociety.org/education/reports/workforce2007.pdf) provides a detailed account of the principal sources of data on the teaching workforce from across the UK. However, we do not claim that the data are exhaustive or complete, as the authorities responsible for collecting and maintaining education do not make freely available all of their holdings. Depending on the institution involved, some of these data may be made available upon request, while other data may only be obtainable at cost. We endeavour to make each type clear throughout the report but we welcome comments and queries from readers on the source and availability of the data we use, or other data available.

New Departmental changes announced on 28 June 2007 meant that the DfES (formerly DfEE) and DTI were replaced by three new Departments:

- The Department for Children, Schools and Families (DCSF) is responsible for all aspects of childhood and families. This includes responsibility for schools and for the successful delivery of 14–19 reforms, as well as the role of colleges in teaching the new diplomas for 14–19 year olds and sixth form college students.
- The Department for Innovation, Universities and Skills (DIUS) is responsible for the productive skills and the educational needs of a competitive economy. Responsibility for the development, funding and performance management of HE and FE will include the work of FE colleges with the exception of the 14–19 diplomas.
- The Department for Business, Enterprise and Regulatory Reform (BERR), which seeks through regulatory reform to promote business success and economic performance throughout the regions.

When quoting data sourced from the Government, we use the departmental title in use at the time of original publication.

2 Cockcroft Committee 1982 *Mathematics counts: a report into the teaching of mathematics in schools.* London: HMSO.

3 Roberts, G 2002 SET for success. *The supply of people with science, technology, engineering and mathematics skills.* London: HM Treasury. (See http://www.hm-treasury.gov.uk/documents/enterprise_and_productivity/research_and_enterprise/ent_res_roberts.cfm)

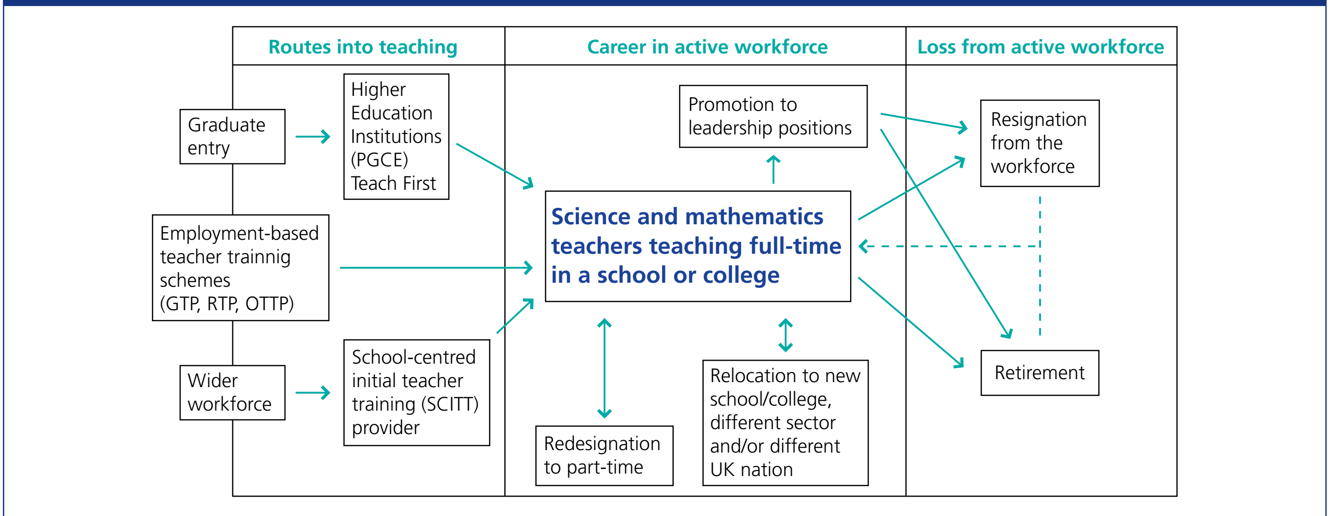
4 Smith, A 2004 *Making mathematics count. The report of Professor Adrian Smith's inquiry into post-14 mathematics education.* London: The Stationery Office.

2 A simple model for the science and mathematics teaching workforce[5]

In figure 2.1 we set out a simple model for the science and mathematics teacher workforce, which introduces the main inflows and outflows that we will consider in detail in the following chapters. (The issue of workforce modelling, to which this figure relates, is a complex process for any profession, and is discussed further in chapter 9.)

Figure 2.1 shows that there are broadly two major routes into teaching, directly through the Postgraduate Certificate in Education (PGCE) or, alternatively, for career movers in other professions, via on the job training in schools or a PGCE. These are discussed in chapter 4. The middle section of the diagram shows the active workforce and illustrates the major career decisions that teachers will face during their teaching careers, including relocation, which may or may not be linked to promotion, retraining to be able to teach another specialism, resignation (which may be reversible, indicated by stippled lines), and factors affecting these, issues which are discussed in chapters 3, 5, 7 and 8. Here it is important to note that contact time with students tends to diminish with increasing responsibility, so a headship (be it head of department, assistant head, deputy head or head teacher/principal) will normally result in reduced or, for headteachers, nil teaching. The right-hand section represents final attrition from the workforce owing to resignation or retirement, discussed in chapter 6. Here it is notable that resignation from teaching provides some teachers with opportunities to take up other, non-teaching, roles in education, for instance those of Ofsted inspector, awarding body examiner, local authority science or mathematics consultant, PGCE tutor or education researcher.

Figure 2.1 Schematic showing flux of science and mathematics teachers into and out of teaching



5 We recognise the value of classroom assistants, technicians, managers and administrators to science and mathematics education but for reasons of data availability and practicality we focus on the teaching workforce in this report.

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

This chapter examines the information available on the UK's science and mathematics teaching workforce over recent years across the maintained school, independent school, and learning and skills sectors. We divide the workforce according to school type, sector and UK nation as these are shaped by different policies, procedures and other circumstances. The active workforce (including trainees) represents the stock from which teachers will be retained and lost in future years. In order to assess the size of the science and mathematics teaching workforce, it is necessary to examine first why specialism is considered important in teaching and the definition of a 'subject specialist' teacher.

3.1 The importance of specialism and its relation to the currency of the 'subject specialist' teacher

Secondary schools in England have, by and large, traditionally placed a strong emphasis on subjects, reflecting the usual structure of the school curriculum. Mathematics has always been seen as a double subject, but the situation in science is more complex. The introduction of the National Curriculum in 1989 reinforced the emphasis on science and mathematics as 'core' subjects that must be taught to all young people throughout their compulsory schooling, but it also tended to treat the disciplines of biology, chemistry and physics (which had historically been taught separately) as one subject, with a minimum requirement as described in the single science Programme of Study in the National Curriculum. Recent policy shifts have tended to reverse this shift at Key Stage 4, for example, the proposal that any pupil attaining Level 6 at the end of Key Stage 3 should be entitled to study the three separate sciences in Key Stage 4.

However, the position of science within the core curriculum has not been quite as secure as first appears. Back in 1998, science became one of three subject areas at secondary level (the others being modern foreign languages and design and technology) that schools were permitted to disapply so as to enable students at Key Stage 4 to follow an extended work-related learning programme. This disapplication led in 1999/2000 to some 13% of the 11,010 young people for whom one or more subjects had been disapplied no longer following a science course at Key Stage 4.[6] This number constituted but a tiny fraction of that year's cohort. Still, in 2000 the rules governing disapplication were extended to enable young people to develop their basic skills, focus more on a particular skill or talent or take up a work-related learning programme, although science could only be disapplied for work-related learning and not for the other two reasons. With the implementation of the Increased Flexibility Programme in 2003, permission to disapply science at Key Stage 4 was more or less rescinded, with the introduction of other science qualifications and routes. It is hard to know what the net impact of these reforms has been, particularly in respect of the perceived requirement for and recruitment of specialist subject teachers.

For their part, primary schools have tended to place less emphasis on subject specialisms, although recent government policy has raised their profile. In 1980 Ofsted endorsed the contribution made by subject specialists at secondary school level,[7] and in 1987 the (then) Specialist Schools Trust was founded.[8]

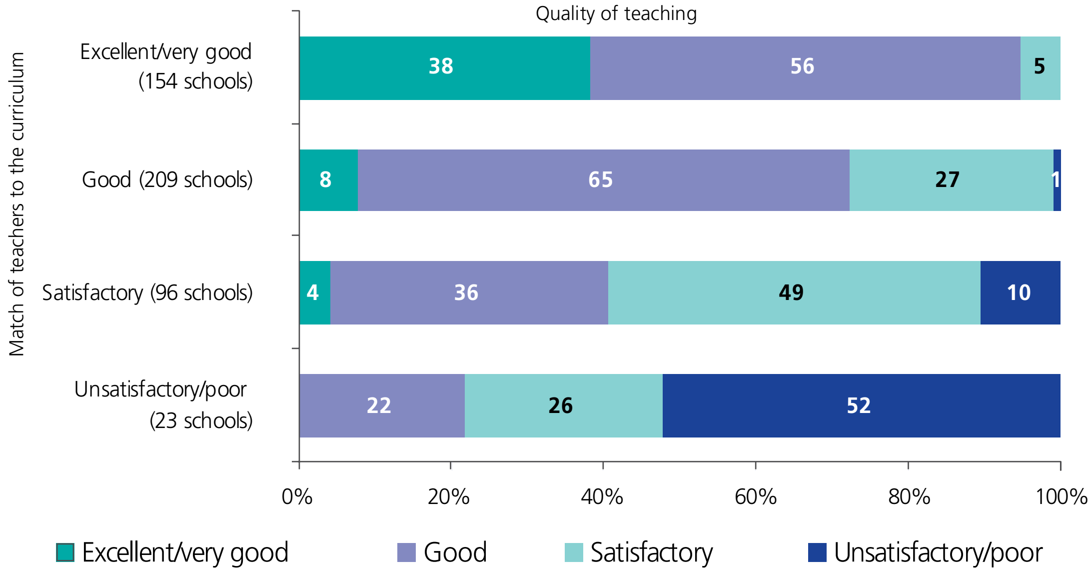
Despite the acknowledged importance of subjects in teaching and learning, there appears to be no singular agreed definition of the term 'subject specialist' in the UK. In England, the term has had more than one connotation, making it difficult to evaluate changes in the numbers of specialists recorded in past DES/DfEE/DfES staffing surveys. A specialist science or mathematics teacher could either mean someone with a background in the subject (but who might not be teaching it) and/or someone who was teaching it

6 Nelson, J, Morris, M, Rickinson, M, Blenkinsopp, S & Spielhofer, T 2001 *Disapplying National Curriculum subjects to facilitate extended work-related learning at key stage 4: an evaluation*, p. 18. DfES Research Report no. 293. London: DfES.

7 HMI 1980. *A view of the curriculum*. HMI Series: Matters for Discussion, no. 11, chapter 3. London: Her Majesty's Stationery Office. (Available online at at http://www.dg.dial.pipex.com/documents/index.shtml)

8 The Specialist Schools Trust became the Specialist Schools and Academies Trust in 2005.

Figure 3.1 Relationship between the quality of teaching and the match of teachers to the curriculum in science (percentage of secondary schools)



Source: Ofsted.

(but who might not necessarily have a background in it).[9] This, coupled with the poor sample size of some of the staffing surveys (see § 3.3.1), led the Royal Society, Royal Society of Chemistry and Institute of Physics to support the DfES in commissioning the National Foundation for Educational Research (NFER) to undertake a study in the academic year 2004/05 examining deployment of mathematics and science staff in maintained secondary schools in England.[10]

In the NFER report, a 'specialist' teacher is defined as one holding 'university qualifications in the subject [s/he is teaching], either at degree level or above or for their ITT [initial teacher training]' (NFER 2006). Curiously, in contrast to the situation in England, where a specialist teacher tends to be defined in terms of his/her qualifications, in Wales and Scotland a 'specialist' teacher is recognised according to the principal subject s/he teaches. In Northern Ireland, however, no official count of the numbers of 'specialist' teachers has yet been conducted.

There may be good reasons to explain this inconsistency, which require disentangling from the varying philosophies that have underpinned curricular development and assessment procedures in each nation. The situation is further complicated by the fact that science teachers may teach both 'science' and one or more of the sciences (physics, chemistry, biology are the main ones). Therefore a science teacher may be both a 'science' specialist and a 'biology' specialist, depending on whether s/he is teaching combined science or biology. Given the variety of science courses and qualifications available from Key Stage 3 through into post-16, it is no longer possible to simplify this definition by applying it to age-range.

In 2003, the DfES asserted rather vaguely in its consultation on subject specialism that an 'adequate qualification' in a particular subject must be the basis for teaching that subject.[11] In addition, various academic studies have shown correlations between subject expertise and teaching quality and the attitudes

9 The newly introduced 'enhancement' courses in England, which are designed to prepare graduates who have a specialist education in one subject (say biology) for a PGCE that will lead to them becoming a specialist teacher in another subject (say physics), add a further layer of complexity to the issue of what it means to be a 'specialist' teacher.

10 Moor, H, Jones, M, Johnson, F, Martin, K & Cowell, E 2006 *Mathematics and science in secondary schools. The deployment of teachers and support staff to deliver the curriculum*. Research report no. 708. NFER Trading Ltd.

11 DfES 2003 *Subject specialism: consultation document*, paragraph 12, p. 3. Sudbury, Suffolk: DfES Publications.

Figure 3.2 Relationship between the quality of teaching and the match of teachers to the curriculum in science at post-16 (percentage of secondary schools)

Source: Ofsted.

of students towards subjects (for more, see Jenkins & Donnelly (2006)[12]).

As was referred to earlier, recognition of the importance of subject specialism has particularly come from the Office for Standards in Education (Ofsted), which has consistently highlighted the positive relationship between specialist knowledge and enthusiasm of teachers and higher student attainment:

'When teachers are thoroughly in command of their subject, they are able to adapt their teaching to the responses of the pupils, to use alternative and more imaginative ways of explaining, and to make connections between aspects of their subject and with pupils' wider experiences, so capturing their attention and interest. The teacher's ability to answer spontaneous questions is an important factor in generating enthusiasm for the subject'.[13]

Ofsted has in the past monitored impacts on the quality of teaching and figure 3.1 shows how, for a sample of 482 schools that were assessed in 2004/05, this is affected by the closeness of the match between the subjects teachers are teaching and the subject(s) that they have a specialism in, where specialism is defined by the subject of a teacher's degree. Overall, there was a strong match between teachers' specialisms and the subjects they were teaching in 363 of the 482 schools sampled (75%), and the quality of teaching varied in accordance with the strength of this match. Where the match of teachers' specialism to the curriculum was excellent/very good, which was the case for 154 schools, the quality of teaching observed was adjudged to be excellent/very good or good in 94% of these schools. By contrast, the quality of teaching was considered to be unsatisfactory or poor in more than half of the 23 schools in which staff specialism was found not to match well with subjects taught.

Notably, in what is probably a reflection of schools' deployment strategies, a weaker relationship was found between quality of teaching and match of teachers to the science curriculum in respect of post-16 teaching and learning, with this being adjudged to be at least satisfactory in the 80 schools sampled, and never unsatisfactory or poor (figure 3.2).

12 Jenkins, E W & Donnelly, J F 2006 Educational reform and the take-up of science post-16. A paper prepared for the Royal Society conference 'Increasing uptake of science post-16' on 10 March 2006. (See http://www.royalsoc.ac.uk/downloaddoc.asp?id=3357)

13 Ofsted 1998 *Secondary education 1993–1997: a review of secondary schools in England*. London: The Stationery Office.

Figure 3.3 Relationship between the achievement of pupils and the match of teachers to the curriculum in science (percentage of secondary schools)

Source: Ofsted.

Similarly, figure 3.3 shows a positive relationship between the match of teachers to the curriculum and pupil achievement (that is, the relative progress they have made, rather than their attainment in statutory national tests). In 92% of the schools in which the fit of teachers' qualifications to the subjects they were teaching was thought to be excellent/very good pupil achievement was also excellent/good. But pupil achievement was poor in more than half (57%) of the schools in which the match of teachers' subject expertise to the subjects they were teaching was adjudged to be poor or unsatisfactory.

A similar relationship has been shown to exist for mathematics for the year 2004/05, although the size of the overall sample was small (Ian Richardson, HMI, Subject Specialist Adviser for Science, Ofsted, personal communication, 30 August 2007).

There are clearly some questions regarding cause/effect of these factors, and the extent to which other factors such as type of school have on the relationships described here. These cannot be explored with the small quantities of data available.

3.2 Maintained primary sector workforce

Some overall statistics on the size of the maintained primary teaching populations in each of the four countries of the UK are provided in table 3.1. Here we concentrate attention on England, whose primary sector is considerably larger than those of the other UK countries.

Although general data are available on the size of the primary workforce in England, it seems that the last time subject specialism in this sector was surveyed was by the DfEE in 1998. Back then, combined numbers on nursery and primary teachers were provided (totalling 213,110 qualified teachers across 18,754 nursery and primary schools, of which 186,590 were full-time), making it impossible to tell how many science and mathematics specialists there were in primary schools.[14]

Throughout the UK, primary teachers are expected to be capable of teaching all subjects and therefore

14 DfEE 1999 *Statistics of education. Teachers England and Wales. 1999 Edition*. London: The Stationery Office. DfEE 1999 *Statistics of education. Education and training statistics for the United Kingdom 1999.* London: The Stationery Office.

Table 3.1 The total population of teachers in primary maintained schools throughout the UK

	Total population[a]	No. of maintained primary schools	No. of teachers (full-time equivalent)	No. of pupils	Pupil/ teacher ratio[f]
England[b]	50,431,700	17,504	196,900	4,148,950	21.8
Wales[c]	2,958,600	1,555	12,862	265,724	19.8
Scotland[d]	5,094,800	2,184	23,501	382,783	16.3
Northern Ireland[e]	1,724,400	896	7,853[g]	168,184	20.8[g]

Sources: a Office of National Statistics online; b DfES SFR38/2006, SFR15/2007; c Key education statistics Wales 2006, published by Welsh Assembly Government, April 2007; d Teachers in Scotland, 2006 (Scottish Executive, 27 March 2007); e Department of Education, Northern Ireland (http://www.deni.gov.uk/index/32-statisticsandresearch_pg/32-statistics_and_research_statistics_on_education_pg/32_statistics_on_education_teacher_numbers_pg.htm); f pupil/teacher ratio does not equate to class size. Note that the published 'in school' PTR for England is not based on the data from the SFRs; the SFR carries data from the 618G survey, whereas the PTR uses unpublished School Census teacher numbers as they are collected in the same survey as the associated pupil numbers; g includes pupils and teachers in nursery classes.

primary teacher training is generalist. It is not surprising therefore that there is no up-to-date detailed knowledge of the number of UK primary teachers with science and mathematics backgrounds. A further concern is that with the 1-year primary PGCE now being the most favoured route into a primary teaching career, there may be insufficient time available to cover the amount of mathematics subject knowledge necessary (Professor Margaret Brown, King's College London, personal communication, 5 September 2007).

However, because science and mathematics are components of the statutory national curriculum for all primary schools,[15] it is important that there are sufficiently competent teachers in each primary school to enable young people at such a formative age to gain an accurate and engaging experience of these subjects. Further, many recent studies stress the importance of primary education in fulfilling the aims of science education.[16]

Certainly in England the system does not seem to be conducive to providing the specialists that are needed. Entrants to primary PGCE courses in England need to have achieved a standard equivalent to a grade C in a GCSE science subject (as well as in English and mathematics) as a minimum, but as data from the TDA indicate (see chapter 4, table 4.3), the numbers of STEM (science, technology, engineering and mathematics) graduates training to become primary teachers has been in the low hundreds and in decline in recent years – which contrasts to the thousands of non-STEM graduates that each year opt to train as primary teachers. Recently, the think-tank Politeia claimed that few primary teachers possess A-level qualifications in science or mathematics, let alone a degree-level qualification in these subjects.[17] So, while each primary school in England should have a science coordinator and a mathematics coordinator, it may be that many are not specialists in these fields.

3.3 Maintained secondary sector workforce

The DCSF/DIUS, Welsh Assembly, Scottish Executive and Department for Education Northern Ireland all collect data about workforce size. Some overall statistics on the size of the maintained secondary teaching populations in each of these countries are provided in table 3.2. The remainder of this section is given over to investigating the proportions of science and mathematics teachers that contribute to these overall figures.

15 In Scotland, primary 'science' is taught under the subject area 'environmental studies'. New curricular arrangements being introduced in Northern Ireland from September 2007 mean that science will be taught as a component within an area of learning entitled 'The world around us' (see http://www.nicurriculum.org.uk/key_stages_1_and_2/index.asp). Following major review, there are plans for a new curriculum to be introduced in Wales from 2008 (see http://accac.org.uk/uploads/documents/1507.pdf), but the extent to which primary science provision will be affected remains to be seen.

16 Examples of such studies include the following: *Primary horizons. Starting out in science* (The Wellcome Trust 2005); *Evolution of student interest in science and technology studies* (Policy Report, OECD, 4 May 2006); *SET for success. The supply of people with science, technology, engineering and mathematics skills.* (The report of Sir Gareth Roberts's Review, April 2002); Council for Science and Technology 2000 *Science teachers. A report on supporting and developing the profession of science teaching in primary and secondary schools*. London: CST.

17 Lawlor, S (Ed.) 2007 *Teaching matters: the recruitment, employment and retention of teachers*, p. 73. London: Politeia.

Table 3.2 The total population of teachers in secondary maintained schools throughout the UK

	Total population[a]	No. of maintained secondary schools	No. of teachers (full-time equivalent)	No. of pupils	Pupil/ teacher ratio[f]
England[b]	50,431,700	3,367	216,300	3,306,570	16.6
Wales[c]	2,958,600	224	12,806	213,045	16.6
Scotland[d]	5,094,800	381	26,083	312,979	12.0
Northern Ireland[e]	1,724,400	228	6,241	87,520	14.0

Source: a Office of National Statistics online; b DfES SFR38/2006, SFR15/2007; c Key education statistics Wales 2006, published by Welsh Assembly Government April 2007; d Teachers in Scotland, 2006 (Scottish Executive, 27 March 2007); e Department of Education, Northern Ireland (http://www.deni.gov.uk/index/32-statisticsandresearch_pg/32-statistics_and_research_statistics_on_education_pg/32_statistics_on_education_teacher_numbers_pg.htm); f pupil/teacher ratio does not equate to class size.

Table 3.3 Full-time secondary science teachers in England by subject of qualification[a]

Year	Biology	Chemistry	Physics	Combined/ general science	Other science
1984	20,700	17,600	19,400	16,300	14,500
1988	18,800	16,600	17,600	13,700	12,300
1992	15,000	15,000	15,900	16,500	13,700
1996	11,300	10,700	10,400	15,500	6,200
Percentage change (1984–1996)	–45.4%	–39.2%	–46.4%	–4.9%	–57.2%

Source: DfES, adapted from Smithers & Robinson (2004).

a Figures have been rounded to nearest hundred.

3.3.1 Estimates of the numbers of specialist science and mathematics teachers in England

There are two main sources of data on the numbers of specialist science and mathematics teachers in England: a comprehensive study by the National Foundation for Educational Research (NFER) published in 2006,[18] and the DCSF's Secondary School Curriculum and Staffing Survey (SSCSS).

The SSCSS was last carried out in 2002/03, but only 209 of the 883 schools contacted actually provided a return, meaning that scarcely more than 5% of all secondary schools in England registered information (see table A3.1). At the time of writing, a new SSCSS is due to be published in Autumn 2007, and we hope that this survey will provide a clearer and more accurate perspective on the numbers of specialist teachers in secondary schools in England.

18 *Op. cit.*, note 10.

An analysis of data from the SSCSSs during the years 1984–1996 (table 3.2) indicates that the number of full-time specialist science teachers in maintained secondary schools in England fell sharply during this period, with the numbers of biology, chemistry and physics 'specialists' practically halving in 12 years[19].

However, these figures are difficult to interpret, owing to:

i. varying, and sometimes unrepresentative, sample sizes;

ii. the fact that the period 1984 to 1996 saw a steep fall of 625,000 pupils in secondary schools; and 1984 survey included sixth form colleges, which were excluded from the 1996 survey;

iii. changes in the way that a subject 'specialist' was defined, a fact acknowledged in paragraph 30 of the 1996/97 survey, which states:

19 Smithers, A & Robinson, P 2004 *Chemistry teachers. A report for the Royal Society of Chemistry*. London: Royal Society of Chemistry.

'The apparent drop in these figures compared with corresponding figures in 1992 … was probably due to difference in the way in which qualification information was collected'; and, possibly connected with this

iv. the fact that between 1985 and 2003 the numbers of teachers on part-time contracts doubled.[20]

A more complete comparison of the staffing surveys in respect of issues (i)–(iii) is provided in table A3.1.

The NFER report, published in 2006, is the most recent and comprehensive survey of science and mathematics staff in maintained secondary schools in England. Evidence for the NFER research was collected via:

i. a postal questionnaire to departmental heads and teachers of maths and science sent to 40% (1,292 schools) of all secondary schools in England

ii. a postal and telephone survey of support staff who assisted in these departments

iii. case-study visits to 12 departments, deemed by their local authority to exemplify good deployment practices in maths or science.

Questionnaires were returned by 773 heads of mathematics and 754 heads of science, representing one-quarter of all secondary schools in England. In addition, 3,220 maths teachers (47% of the teachers of maths in responding schools) and 2,756 science teachers (42% of the teachers of science in responding schools) responded to the teacher survey.

The achieved head of department and teacher survey samples were representative of the national picture in terms of Government Office Region, the age range of schools (for example, 11–16, 11–18) and school size. All data were collected in the summer term of the academic year 2004–2005.

Applying the definition quoted in § 3.1, the NFER report estimated on the basis of data collected from 780 maintained secondary schools (equivalent to one in four such schools across the country), that there were 30,985 teachers teaching science, of whom 28,781 were specialist science teachers (13,700 biology specialists, 7,906 chemistry specialists and 5,797 physics specialists and 1,378 other science specialists), leaving 2,204 teachers of science who were non-specialists or principally taught other subjects. The report also estimated that there were 21,126 specialist mathematics teachers (including 11,652 who have a degree in mathematics) in England.[21]

Back in 1988, the DES's Secondary School Staffing Survey estimated, on the basis of a 10% sample of schools that volunteered responses, that there were 29,464 full-time science teachers with science qualifications in England (Smithers & Robinson 1990).[22] Unfortunately, due to variability in the quality of subsequent staffing surveys, no clear trend over the period 1988–2006 is discernible concerning the number of specialist science teachers. The NFER report also indicated that there were a further 2,200 non-specialist science teachers in England, but there is no comparable historic figure to which this may be related.

In 1991 a report was published by the Association for Science Education, British Association and the Royal Society (following the work by Smithers & Robinson (1990)[23])[24] based on a survey sample of 1008 science teachers, of which 719 (or 71%) worked in maintained (11–16 and 11–18) schools, which estimated that there were 33,000 science teachers in maintained schools in England and Wales.

Comparison between the ASE/BA/RS (1991) survey and the NFER (2006) study (table 3.3) is problematic owing to differences in method and of definitions: (i) the inclusion of the independent sector in the ASE/BA/RS study, a sector understood to attract and retain more specialists in the physical sciences; (ii) the uncertain status of non-specialist science teachers in the ASE/BA/RS study; and (iii) the different definitions of subject 'specialist' between the studies.[25] However, table 3.4 indicates a decline in the proportions of science teachers with a degree in a science subject from 96.6% in 1991 to 76% in 2006 (notwithstanding the fact that the NFER survey records a further 11% of science teachers that had a post A-level qualification

20 Bird, E 2003 To what extent can diversification of routes to qualified teacher status contribute to the supply of mathematics teachers? In *Shortage of mathematics teachers – what progress?* Proceedings of a National Day Conference, pp. 71–106. Milton Keynes: The Open University.

21 The NFER's definition of a 'non-specialist' teacher of science includes someone whose specialism is non-science-related or principally teaches non-science subjects.

22 Smithers, A & Robinson, P 1990 *Teacher provision in the sciences*. [Report] commissioned by the British Association, the Association for Science Education and the Royal Society. Manchester: School of Education, University of Manchester.

23 *Ibid.*

24 ASE/BA/Royal Society 1991 *Only a teacher…? An enquiry into science teacher provision*. Hatfield: ASE.

25 *Ibid*. The ASE/BA/Royal Society report records science teachers by subject of qualification according to whether they hold a degree or teachers' certificate in that subject. It does not make the additional distinctions that the NFER study makes.

Table 3.4 Percentages of science specialist teachers (by degree held) in schools in England recorded in two studies [a]

Subject of qualification/ teaching specialism	ASE/BA/RS study (1991) (*n* = 878)[b]	Proportions of specialists[e]	NFER study (2006), table 6.3 (*n* = 3,510)	Proportions of specialists[e]
Biology	33.3%	34.5%	27%	35.5%
Chemistry	23.7%	24.5%	17%	22.4%
Physics	18.8%	19.5%	11%	14.5%
General science	5.2%	5.4%	6%	7.9%
Other science	15.6%	16.1%	15%	19.7%
Total percentage of science specialists	96.6%[c]	100%	76%[d]	100%

Sources: ASE/BA/RS (1991); NFER (2006).

a Definitions of specialist differ, but for the purposes of this analysis are considered approximately equivalent. Data do not sum to 100 owing to exclusion of other categories of teachers

b Sub-sample made up of 719 maintained school teacher and 159 independent school teacher respondents.

c This figure excludes 3.4% of full-time teachers teaching science who held a non-science degree.

d This figure excludes 24% of science teachers who held either a BSc or BA with QTS in general or another science or a BEd in science, a CertEd incorporating science (most of which had specialised in biology), PGCE incorporating science (ie people whose first degrees were in a science subject other than biology, chemistry, physics, general science or other science who also hold a PGCE), other post-A-level science qualification, no post-16 science qualification and less than 1% of teachers who failed to reply to this question in the survey.

e Figures in this column relate the proportions of specialists in the previous column calculated as a percentage of the total percentage of science specialists recorded in the previous column.

in science, mainly linked to a teaching qualification (eg BSc or BA with QTS or BEd in science)). In addition, the proportions of physics and chemistry specialists within the science teaching workforce also seem to have fallen during this 15 year period.

For trends in the number of mathematics specialists, we look to the Smith report *Making Mathematics Count*, which showed that numbers of specialist mathematics teachers across both England and Wales have been in long-term decline, with SSCSSs from 1988, 1992 and 1996 showing that combined numbers of full- and part-time teachers in mathematics were, respectively, 46,500, 43,900 and 30,800 (Smith 2004, p. 23).[26] It is important to note, that this period experienced an overall fall in the roll of full-time-equivalent secondary school-age learners (including sixth form colleges), from 3,070,200 (in 1984) to 2,905,800 (in 1992), before a recovery to 3,024,800 (in 1996).[27]

There are clear weaknesses in centrally administered surveys of teachers in schools, not least because they rely on intermediaries in schools to record the qualifications of staff (see text accompanying table A3.1). In areas such as London where staff mobility is high, this problem is made worse.

As a possible alternative to the staffing surveys, we explored the data kept by the General Teaching Council of England (GTCE). All qualified teachers teaching in the maintained sector, regardless of whether they are full-time, part-time or supply teachers, are required to register with their General Teaching Council (GTC) and therefore the data are teacher- rather than school-specific. The GTCs of England, Wales and Scotland were formally established together by the Teaching and Higher Education Act 1998 and the GTC Northern Ireland was set up that same year by Education (Northern Ireland) Order 1998. Although we have found that the GTCE does not collect information on the subject qualifications of its members, the GTCE's website does currently state that 'In future years, as the database becomes increasingly comprehensive, the digest will become fuller and more detailed to include addtional [*sic*] information, for example on ethnicity, subject and other specialisms of teachers. As we develop the Register's capacity we will be able to provide valuable evidence on matters such as recruitment and retention.'[28]

26 *Op. cit.*, note 4.

27 Source: DCSF.

28 See http://www.gtce.org.uk/aboutthegtc/publications/corporate/statdigest/?aButton=2

Table 3.5 Comparison of the current constitution of the secondary science and mathematics teaching community across the UK

	England (NFER's survey-based projection)		Scotland[a]		Wales[b]		Northern Ireland
	Number	%	Number	%	Number	%	
Biology	13,700	47.6%	1,156	34.9%	510	19.2%	No data available
Chemistry	7,906	27.5%	1,020	30.8%	461	17.4%	No data available
Physics	5,797	20.1%	936	28.3%	426	16.1%	No data available
Other science	1,378	4.8%	200	6.0%	1,253	47.3%	No data available
Total number of specialist science teachers	28,781	100%	3,312	100%	2,650	100%	No data available
Total number of specialist mathematics teachers	21,126	N/A	2, 654	N/A	1,581	N/A	No data available

Sources: NFER (2006) p. 113; Scottish Executive (2007), p. 22; GTCW (2007).

a *Ibid*. Data cover all secondary school teachers by main subject taught collected by local authorities. Page 23 of this publication includes alternative data from the GTCS, which distinguishes teachers who are registered to teach particular subjects from teachers who are currently teaching particular subjects. The former gives the following equivalent information: total no. of specialist science teachers = 6,625, of which 1,731 (26.1%) are biology specialists, 1,658 (25%) are chemistry specialists, 1,276 (19.3%) are physics specialists and 1,960 (29.6%) are general science specialists. The latter gives the following equivalent information: total no. of specialist science teachers = 5,852, of which 1,351 (23.1%) are biology specialists, 1,209 (20.7%) are chemistry specialists, 1,029 (17.6%) are physics specialists and 2,263 (38.7%) are general science specialists.

b Data received 4 April 2007. The considerably greater numbers of general science teachers in Wales compared with that in Scotland seems strange, and perhaps needs to be investigated further. It is only very recently that teachers in Wales have been asked to give details of their specialism and it may be that accurate data have yet to be collected.

3.3.2 Estimates of the numbers of specialist science and mathematics teachers in Wales

In response to a specific request, data received from the General Teaching Council of Wales indicate that, as of 4 April 2007, there are 2,860 registered science/mathematics teachers in Wales teaching at least one science/mathematics subject, across a total of 224 secondary schools. Breaking down the reported number between subjects shows a total of 510 biology specialists, 461 chemistry specialists, 426 physics specialists, 1,253 general science specialists and 1,581 mathematics specialists. (It is important to note that 619 of the registered teachers report specialist status in more than one subject.) Unfortunately, the GTCW does not keep historical data. Of all the GTCs, only the GTCW maintains a 'real time' database of workforce statistics, the accuracy of this being dependent on whether or not teachers provide the GTCW with the information requested of them[29].

3.3.3 Estimates of the numbers of specialist science and mathematics teachers in Scotland

As was highlighted in § 3.1, specialist teachers in Scotland are defined according to their main subject of teaching. Latest comparative data from the Scottish Executive reveal that there were 5,954 specialist science and mathematics teachers, spread across 385 secondary schools, including 1,156 specialist biology teachers, 1,021 chemistry specialist teachers, 936 physics specialist teachers, 188 general science specialist teachers and 2,653 mathematics specialist teachers.[30] It is worth mentioning that the GTCS does publish subject-specific information on science and mathematics teachers, which it makes available in its annual Statistical Publications.

3.3.4 Estimates of the numbers of specialist science and mathematics teachers in Northern Ireland

The GTCNI produced its first *Digest of Statistics* in December 2006, and currently neither it nor the Department of Education, Northern Ireland (DENI),

29 'The data in the Register are 'real time', therefore historical retrospective analyses are not possible – as such we are unable to provide data as requested for several years' (Hayden Llewellyn, Deputy Chief Executive, GTCW, personal communication, 22 March 2007).

30 Scottish Executive 2007 *Teachers in Scotland, 2006*. Edn/G5/2007/02, 27 March 2007, p. 24.

Table 3.6 Comparison of the current constitution of the science and mathematics teaching community across Scotland and Wales

	Scotland				Wales			
	Total	Female	Male	% Male	Total	Female	Male	% Male
Biology	1,156	729	427	36.9	510	319	191	37.5
Chemistry	1,020	480	540	52.9	461	246	215	46.6
Physics	936	227	709	75.7	426	138	288	67.6
Other science	200	105	95	47.5	1,253	598	655	52.3
Mathematics	2,654[a]	1,387	1,266	47.7	1,581	805	776	49.1

Sources: Scottish Executive (2007); GTCW (2007)

a As published. The individual totals for male and female teachers provided sum to 2,653. The figure for the percentage of male mathematics specialists in Scotland is based on the total of 2,653, but the difference is not significant.

collects subject specialist data on science and mathematics teachers in Northern Ireland. However, the DENI intends to collect such disaggregated data in future (Helen McClure, Statistics and Research Branch, DENI, personal communication, 5 April 2007).

3.4 Comparison of specialist science and mathematics teacher data from England, Wales and Scotland

Given that there appears to be no universal agreement across the UK on what is to be understood by the term 'specialist' teacher, and the lack of any specific data on Northern Ireland, it is impossible to establish accurate numbers and the distributions of specialist science and mathematics teachers in the UK. Using the most up-to-date data available (as presented above), it is only possible to make some sort of cross-country comparison of the current situation (tables 3.1 and 3.4).

While the definition of subject specialist may be more straightforward for mathematics, the discussion above makes it clear that neither *ad hoc*, nor ongoing, surveys have in the past been able to assess and monitor accurately trends in the number of science and mathematics teachers in the workforce in England, nor can we provide an accurate answer to the question of how many exist at any one time. The DCSF is planning to replace the SSCSS with a new School Workforce Census, which is being piloted in 2008 and is expected to be fully operational in 2010. Unfortunately, the census will not include independent schools as the DCSF does not have the necessary statutory powers to be able to collect data from the independent sector (Ian Taylor, DCSF, personal communication, 17 October 2007).

Clearly the GTCE, GTCS, GTCW and GTCNI are independent of one another and each has its own separate policies and protocols concerning the information it collects and keeps on the workforce. Devolution has ensured that the governing body of each constituent nation of the UK has taken on responsibility for collecting and maintaining its own records of its workforce, and indeed determining the information it is prepared to make freely accessible.

Finally, current estimates of the size of the secondary science and mathematics teaching workforce do not take account of the independent schools sector or indeed the staffing of British schools abroad, of which there are more than 130. Investigations have demonstrated that there is a dearth of information on the independent sector. The Independent Schools Council (ISC) represents 1,280 independent schools across England, Scotland and Wales employing a total of 44,618 full-time teachers and a further 14,212 part-time teachers. However, the ISC does not have specific information on the numbers of mathematics and science teachers (Corinna Elsenbroich, ISC, personal communication, 30 April 2007), although it has highlighted the total flow of teachers (across all subjects) from and to the state sector (cf. chapters 6 and 7). The Scottish Executive, too, has begun to look into collecting data on subjects taught by teachers in the independent sector (Mal Cooke, Scottish Executive, personal communication, 1 May 2007). Owing to this gap in knowledge, it is only possible to discuss the science and mathematics teaching workforce in the maintained schools sector.

Table 3.7 Numbers of science and mathematics teachers in the learning and skills sector compared with total numbers of teachers across the other 14 main strands of learning

	Part-time teacher		Full-time teacher	
	Male	Female	Male	Female
Science and mathematics teachers	1,792	2,379	2,648	2,074
Total numbers of teachers (all subjects)	28,705	53,756	25,093	24,596
Science and mathematics teachers as a percentage of all teachers	6.2%	4.4%	10.6%	8.4%

Source: LLUK (2005).

3.4.1 Gender of the schools' workforce

Unfortunately, the DCSF's records of the gender of specialist subject teachers are poor. Primary and secondary teachers are combined in measures of science and mathematics specialists. Moreover, the table containing this information was discontinued after 2003.[31]

As noted previously, Northern Ireland does not maintain records of its subject-specialist teachers. However, it is possible to break down the figures in table 3.5 for Scotland and Wales by gender, and this breakdown is provided in table 3.6. Table 3.6 indicates that there are proportionately fewer male than female biology and mathematics teachers in both Wales and Scotland, but that more than two-thirds of physics teachers in each of these countries are male. In chemistry there is a more even gender distribution of specialists. A slightly greater proportion of male chemistry specialists exists in Scotland than in Wales, but Scotland has more than double the number of these specialists. In contrast, Wales has a greater proportion of male other (general) science specialists than Scotland, and more than six times as many of these specialists.

3.4.2 The learning and skills sector

A universal problem is the poverty of information on the teaching workforce in the learning and skills sector, and the low priority given to the issue by policy-makers. This diverse sector includes general further education (FE) and tertiary colleges (GFECs), sixth form colleges (SFCs), special colleges (eg agriculture and horticulture) and specialist designated colleges. The most recent statistics available indicate that there are a total of 409 colleges in England (including 267 GFECs, 104 SFCs, 24 special colleges and 14 specialist designated colleges), 43 FE colleges in Scotland, 25 FE colleges in Wales and 16 FE and Higher Education colleges in Northern Ireland.[32]

It is possible to find general data on the total size of the teaching workforce in further education colleges throughout the UK, and these are made freely available by the UK government and the assemblies of the devolved administrations.[33] However, just as Adrian Smith's attempts during 2002–2004 to find reliable data on the mathematics workforce were frustrated, so this study has found that detailed disaggregated data on the science and mathematics workforce in the learning and skills sector are still lacking. While table A1.1 indicates that overall numbers of learners in colleges have been falling, figures obtained from the DCSF for 2005/06 nonetheless show that across the sciences and mathematics, one-third of all AS-level examinations were taken by learners in colleges (32.5% and 33.5%, respectively), and that college learners accounted for almost a quarter (24.1% and 23.4%, respectively) of all science and mathematics A-level entries. Given that A-levels are the most common route into science and mathematics studies in higher education,[34] the lack of information about who is teaching such significant numbers of potential scientists and mathematicians is of concern.

31 See DfES V02/2005, ISBN 0-11-271173-1.

32 LLUK 2005 Further education workforce data for England. An analysis of staff individualised record (SIR) data 2004/05; LLUK 2006 Scotland National Manager's Report August 2005–March 2006; Fforwm; Association of Northern Ireland Colleges.

33 Notably, teachers in the learning and skills sector are not required to register with the General Teaching Council.

34 Royal Society 2006 *A degree of concern? UK first degrees in science, technology and mathematics*, p. 17. Policy document 31/06. London: The Royal Society.

Lifelong Learning UK (LLUK), which has now taken over responsibility for the learning and skills sector workforce from the Learning and Skills Council (LSC), has published general data in its staff individualised reports, but only limited information relating to the combined science and mathematics staff (see table 3.7). These data show that, together, science and mathematics teachers (designated by main subject taught) make up just 6.7% of all part- and full-time teachers in this sector; and that, of these, there are almost as many part-time teachers as there are full-time teachers. The handover from LSC to LLUK is not yet complete and LLUK does not expect more detailed data to be available on the science and mathematics workforce for a further 2 years at least (Simon Utting, LLUK, personal communication, 2 May 2007).

Conclusions

i. We cannot state accurately how many specialist science and mathematics teachers there are in the UK, nor can we reliably report on recent trends in numbers or teachers' age/length of experience.

ii. There are not reliable, consistent systems in place to collect data, nor is there an agreed definition of a subject specialist.

iii. There is a potential for the General Teaching Councils to collect data on the teaching workforce, while Governments might concentrate on the distribution and deployment of that workforce across schools.

iv. There is a need for the size of the science and mathematics teacher workforce in the independent sector to be accurately assessed and for this information to be shared.

v. Given the clear lack of consistent, reliable and detailed data available, we must hope that the new School Workforce Census that the DCSF is committed to undertaking delivers substantially improved information compared with the staffing surveys previously conducted in England.

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.

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

This chapter is concerned with the recruitment of new science and mathematics trainees into initial teacher training (ITT), or initial teacher education as it is sometimes called, and the workforce. In particular we explore how ITT is contributing to increasing the proportion of specialist subject teachers. In the course of this chapter we describe the routes to gaining Qualified Teacher Status (QTS) and whether it is possible to assess the quality of new recruits.

We note that the independent school workforce includes unqualified teachers but in this report we focus entirely on the recruitment of qualified (or intending to qualify) teachers.

4.1 Major routes into teaching

The main route into a teaching career is through a course of initial teacher training (ITT), which may be undergraduate, postgraduate or employment-based. In addition, it is possible for non-ITT qualifiers, such as teachers from countries outside the EU, to join the profession. There are a number of major schemes available for training new teachers, which are presented in table 4.1 (cf. figure 2.1).

In England, Wales and Northern Ireland, the most popular route into a teaching career, particularly at secondary level, has been through the Postgraduate Certificate in Education (PGCE), or its Scottish equivalent, the Postgraduate Diploma in Education (PGDE). The basic qualification requirements needed for a PGCE for secondary teaching are a UK undergraduate degree and, in addition, a grade C in GCSE English language and mathematics (or recognised equivalent overseas qualifications).

Table 4.1 The major routes into teacher training available throughout the UK[a]

Programme	Course	Common abbreviation	Availability in the UK			
			Eng.	Wal.	Scot.	NI
Undergraduate	Bachelor of Education	BEd	✓	✓	✓	✓
	Bachelor of Arts/Science with qualified teacher status	BA/BSc with QTS	✓	✓	✓	✓
Postgraduate	Postgraduate/Professional Graduate Certificate in Education	PGCE	✓	✓	✓	✓
	Postgraduate Diploma in Education	PGDE	✗	✗	✓	✗
	Teach First	Teach First	✓	✗	✗	✗
	School-centred initial teacher training	SCITT	✓	✗[b]	✗	✗
Employment-based	Graduate Teacher Programme	GTP	✓	✓	✗	✗
	Registered Teacher Programme	RTP	✓	✗[c]	✗	✗
Assessment-only routes	Qualified teacher status only	QTS	✓	✓	✗	✗
Overseas trained teachers	Overseas trained teacher programme	OTTP	✓	✓	✓	✓

a Adapted from TDA (http://www.tda.gov.uk/Recruit/thetrainingprocess/typesofcourse.aspx).

b No SCITT exists in Wales, but the Marches Consortium (in Leominster) offers training in some schools in Wales.

c The RTP is being discontinued in Wales in 2007.

The evidence presented in succeeding subsections focuses on PGCE/PGDE training and data on employment-based routes (EBRs) into secondary teaching. However, it is important to acknowledge that there are other valuable initiatives that seek directly, or indirectly, to promote teacher recruitment, and these are discussed briefly in the following subsection.

4.2 Other routes into teaching for those studying science and mathematics

Table 4.1, which is based on one published by the Training and Development Agency (TDA) for Schools, focuses on principal routes into teaching. However, there are other special schemes that provide opportunity for science and mathematics graduates, or graduates in other subjects, to be trained as teachers.

For example, the Inspire programme, based at Imperial College London, enables postdoctoral researchers in the course of their postdoctoral research, or PhD graduates at the end of their research degree, to train as teachers. Since its establishment in 2002, 13 postdoctoral researchers have been accepted on the scheme, 2 of whom were physicists, the remaining 11 being life scientists. Twelve have since successfully completed their PGCE and, of these, 6 have taken up positions in secondary schools or FE colleges (Dr Naheed Alizadeh, Imperial College, personal communication, 6 September 2007).

Following the initial success of Inspire, there are plans to expand the scheme nationally from 2008, involving a collaboration of five universities. At the same time the scheme is to be revised to focus purely on physics and chemistry, the aim being to train 250 new teachers of these subjects over a 5 year period.

In addition to Inspire, graduates wishing to train as science (physics and chemistry) or mathematics teachers who hold degrees that included little science or mathematics content may gain a deeper knowledge and understanding of science/mathematics by taking either an extended 2 year PGCE course, or a pre-ITT subject 'enhancement' course (available in chemistry, physics or mathematics).

In addition, the Student Associates Scheme, a national programme funded by the TDA, provides an opportunity for students registered on HND, foundation degree, undergraduate degree and postgraduate programmes in shortage subjects with an interest in teaching to gain some classroom experience in, particularly, 'challenging' schools, and offers a tax-free bursary of around £40 for each of the 15 days spent in school or college that the scheme allows for. In its response to the House of Lords Science and Technology Select Committee's report into *Science teaching in schools*, the Government indicated that, since it was established in 2003, the scheme 'has placed more than 25,000 students into classrooms, the vast majority of which have been in secondary priority subject areas such as science and mathematics … [with] somewhere in the region of 40% of participants [in the scheme] going on to Initial Teacher Training'.[35]

Finally, it is worth mentioning that the Undergraduate Ambassadors Scheme (UAS) offers teaching experience to undergraduates. Since the initial pilot with 28 students in 2002/03, the UAS now supports over 500 undergraduates, of whom, on average, around 23% opt to pursue teacher training (Brian Lockwood, UAS National Manager, personal communication, 13 July 2007).

4.3 Changes to the PGCE

We note that from September 2007 two types of PGCE course are available: the traditional Postgraduate Certificate in Education and a new Professional Graduate Certificate in Education. This change was prompted by a review undertaken by the Quality Assurance Agency (QAA) for Higher Education, which led to a joint statement in 2005 by the QAA, the Universities Council for the Education of Teachers (UCET), Universities UK and the Standing Conference of Principals (see http:www.qaa.ac.uk). This statement recognises the need to distinguish between PGCE courses aimed at Honours level (Professional Graduate Certificate in Education courses) and those that are pitched beyond Honours level (Postgraduate Certificate in Education courses).

In the light of this new classification, it is notable that responsibility for determining the appropriate PGCE descriptor lies with the individual higher education institutions. According to a survey by the UCET, 18% of ITT institutions were planning to offer only the masters-level PGCE and 77% were planning to offer both types of PGCE.[36]

35 House of Lords Science and Technology Committee's report into science teaching in schools: the Government's response, p. 9. Available online at http://www.parliament.uk/documents/upload/stGovRespTeaching.pdf

36 Barker, I 2007 Spot the difference. *TES*, p. 20, 9 March 2007.

Figure 4.1 UK university departments offering undergraduate chemistry degrees (including subject combinations) and those offering Postgraduate/Professional Graduate Certificate in Education courses in chemistry

UK university chemistry departments.

UK universities with a department offering chemistry PGCE courses.

Source: Updated and adapted from Education Data Surveys Ltd (2006).[37]

Figure 4.2 UK university departments offering undergraduate physics degrees (including subject combinations) and those offering Postgraduate/Professional Graduate Certificate in Education courses in physics

UK universities with a department offering physics PGCE courses.

UK university physics departments.

Source: Updated and adapted from Education Data Surveys Ltd (2006).[38]

4.4 The number and distribution of institutions providing ITT in science and mathematics in the UK

Two factors that affect the numbers of applications and acceptances to science and mathematics PGCE courses are the extent to which (i) these courses are available to potential applicants and (ii) feasible for ITT providers. A diversity of institutions in the UK provides PGCE courses, but by no means do all offer science and mathematics teacher training. Moreover, for those that do provide teacher training in the sciences, there is a great variety of provision available. The major source of information on PGCE applications and acceptances is the Graduate Teacher Training Registry (GTTR), which collects information from nearly all ITT institutions in England, Wales and Scotland, but does not take account of (i) Northern Ireland; (ii) the University of Paisley; (iii) some school-centred initial teacher training SCITT) centres; and (iv) The Open University.

37 Education Data Surveys 2006 *The pay and recruitment of science teachers. Report commissioned by the Gatsby Charitable Foundation*. Oxford: EDS.

38 *Ibid*.

Table 4.2 Numbers of GTTR institutions offering individual, and combinations of, science and mathematics PGCE courses (2000–2006)

Subject/subject combinations	Number of provider institutions by year							Percentage change (2000–2006)	Course provision as a percentage of total ITT providers (2006/07)
	2000	2001	2002	2003	2004	2005	2006		
Biology	36	37	41	40	41	40	38	6%	29%
Chemistry	36	36	40	40	40	40	38	6%	29%
Physics	34	36	38	40	41	40	39	15%	30%
Combined science	41	40	41	43	48	56	53	29%	40%
Mathematics	68	66	69	73	78	82	80	18%	61%
Environmental Science	1	1	1	1	1	1	1	0%	1%
Geology	2	2	2	2	2	2	1	0%	1%
Biology, chemistry and physics	33	36	36	39	40	38	36	9%	27%
Total no. of providers	**121**	**123**	**125**	**130**	**134**	**136**	**132**	**9%**	

Source: GTTR Annual Reports 2000–2006.

Note: Per year increases in the total number of providers do not simply reflect the number of new institutions joining each year as there is a small degree of flux in provider s' participation.

4.5 The number and distribution of ITT providers offering PGCE courses in science and mathematics in the UK

Figures 4.1 and 4.2 show the UK-wide distribution of university chemistry and physics departments compared with those offering PGCE courses in these subjects, and they show that, despite closures or mergers of university science departments, the two correlate quite closely, although the south-west and north-east are not so well provisioned.

Table 4.2 shows that with the exception of geology and environmental science PGCE courses, the total numbers of providers have changed over the past 7 years across all the institutions throughout England, Wales and Scotland whose applications to PGCE courses are managed by the GTTR. It is important to note that acceptances onto these courses vary from year to year across institutions according to (i) the provision a particular institution decides to offer and (ii) the way in which institutions allocate places from the total allocation determined by the Training and Development Agency (TDA) in England, the Scottish Executive (or SHEFCE) and the Welsh HEFCEW.

Table 4.2 shows that with the exception of geology, environmental science and physics PGCE courses, the number of providers of science and mathematics PGCE courses increased overall between the years 2000 and 2006. Over the same period the total number of institutions offering ITT increased by 9%, suggesting a new market for provision in science and mathematics. The relatively large increases in the number of providers offering PGCE courses in physics and mathematics suggest these subjects have been growth areas, compared to biology and chemistry. In 2006, the proportion of ITT providers offering combined science PGCE courses was 40% (compared to 29% offering Chemistry PGCE courses) when the market share of acceptances to combined science PGCE courses was 56% of all science PGCE acceptances in 2005/06.

However, the increase in the numbers of science and mathematics PGCE courses seems to have resulted from new SCITT centres and partnerships being established rather than from new higher education institutions joining the list of training providers. Furthermore, the overall increase in the numbers of providers offering science and mathematics PGCE courses probably reflects the fact that more money has been made available for teacher training in these subjects consistent with allocations increasing from 2,390 to 3,325 (in science) and from 1,680 to 2,350 (in mathematics) during this time.

4.5.1 The distribution of ITT providers offering PGCE courses in science in 2005/06

Further investigation of the data behind table 4.2 enables details to be shown of the 38 institutions across England, Scotland and Wales that offer all of the separate sciences (table A4.1).[39] Table A4.1 shows that 82% of these institutions are Russell Group or Pre-92 institutions, though only 13 out of the 20 Russell Group institutions are represented (Cardiff University does not provide ITT in the sciences, the University of Sheffield only provides ITT in mathematics and combined science, the University of Liverpool, LSE and UCL do not offer ITT, while Queen's University Belfast is not covered by the GTTR (see § 4.4)).[40] Five other institutions (see table A4.2) were recorded as offering one, or more than one, PGCE course in the separate sciences, accounting for, respectively, 3%, 1% and 2% of all biology, chemistry and physics PGCE course acceptances in 2005/06.

The 38 institutions that offered PGCE courses in all the separate sciences were responsible for only 12% of all the combined science PGCE places, ie amounting to only 125 or so people in these institutions. Combined science is offered by 56 institutions, of which just 7 are Pre-'92 or Russell Group (see table A4.3). This shows that more than three-quarters of combined science provision is provided for by newer universities, SCITT centres and colleges.

4.5.2 Mathematics PGCE provision among GTTR institutions (2005/06)

Table A4.1 also shows that the same 38 institutions that offer all of the separate sciences account for 59% of acceptances to mathematics PGCE courses. The remaining 41% of acceptances to mathematics PGCE courses are accounted for by the five other institutions that offer at least one of the separate sciences (104 acceptances, *viz*. table A4.2) and a group of other providers that do not offer PGCE courses in the separate sciences (746 acceptances), listed in table A4.4.

If one assumes that the ability to offer PGCE courses in particular subjects is related to a higher education institution's academic provision (and prowess) in those subjects, it is worth bearing in mind that from 1998 to 2007 there have been, respectively, 31% and 14% falls in the numbers of single honours chemistry and physics degree courses, an 8% drop in single honours mathematics degree courses in England, a 10% drop in single honours science and mathematics courses across the UK and associated declines in the numbers of UK-domiciled first-degree graduates in these subjects within this time-period (table A4.5).[41] In practice, however, anecdotal information suggests that rarely is there a meaningful link between a higher education institution's subject departments and its education department, even to the point of the former providing PGCE students. And as figures 4.1 and 4.2 show there is a close match across the UK between science departments and those running PGCE courses in the physical sciences.

4.6 The match of degree background to PGCE course

Not all graduates wishing to train as teachers choose a PGCE course which directly reflects their degree subject. TDA performance profiles, 2005, covering the year 2002/03, have shown that of the 297 physics graduates who embarked on science PGCE courses in 2002, only 52% trained as physics teachers, while 57 (19%) chose to train as mathematics teachers and a further 56 (19%) opted for combined science.[42] By contrast, of the 880 holders of first degrees in biology that entered into initial teacher training, this being the most popular subject among the cohort of 2002 teacher trainee entrants, 31% opted for combined science.

4.7 Recruitment into primary teacher training

Aggregate data obtained from the TDA for primary PGCE course entry in 2004–2006 reveal falling numbers of science, technology, engineering and mathematics (STEM) graduates opting to undertake primary teacher training (table 4.3). This may reflect a drop in graduates in these subjects, as well as competition from other

39 For convenience, this calculation considers the Swansea Institute of Higher Education as part of University College of Swansea (following the incorporation of the former by the latter in 2004).

40 Imperial College offers ITT to small numbers of postgraduates through its Inspire scheme (*viz.* § 4.2).

41 University and College Union 2006 *Degrees of decline? Core science and mathematics degree courses in the UK 1998–2007*. London: UCU.

42 Smithers, A & Robinson, P 2006 *Physics in schools and universities. II. Patterns and policies*, p. 45. University of Buckingham: Carmichael Press.

Table 4.3 STEM graduates into PGCE primary courses

Year	STEM graduates into primary PGCE[a]
2004	428
2005	389
2006	227

Source: TDA (by permission).

a JACS codes by which STEM graduates are defined: C, biology; F, chemistry and physics; G, mathematics and ICT; H, engineering – mapped up; J, technology – mapped up.

jobs, including teaching in the secondary sector where these subjects have a higher premium in terms of training incentives. Nonetheless, given that the total numbers of graduates accepted onto primary PGCE courses were 10,228 (in 2004), 10,405 (in 2005) and 9,937 (in 2006), it is striking just how small a proportion of these were STEM graduates.[43]

It is worth noting that while a Bachelor of Education (BEd) used to be the traditional route into a primary teaching career, recent years have witnessed fewer numbers training via this route. Although data exist on the total numbers of BEd graduates, it is not possible to distinguish the numbers of those who chose to take specialist options.

4.8 Applicants and acceptances to science and mathematics PGCE courses across the UK

4.8.1 Applicants and acceptances across England, Wales and Scotland

This section considers the popularity of science and mathematics PGCE courses through the numbers of applicants to these courses, and how many of those applicants are accepted onto courses. It should be noted that applicants do not equate with applications, as applicants are able to apply to up to four courses. In addition, not all acceptances result in trainees since applicants may withdraw their application and their place at any time. Those who withdraw from a course, either prior to its commencing or during the course, are considered 'non-completers' and are discussed later in the report.

43 GTTR 2007 *Annual Statistical Report 2006*, Entry Table B, p. 3. Cheltenham: GTTR.

Table 4.4 compares the numbers of applicants and acceptances in physics, chemistry, biology and mathematics for both males and females across England, Scotland and Wales during 2001–2006. Owing to the fact that environmental sciences and geology PGCE courses are only available in England and attract so few – and, indeed, dwindling – numbers of applicants, these are excluded from the analysis. Unfortunately, the GTTR does not freely publish information on the numbers of institutions to which applicants apply, so it is not possible to gain more accurate data on the number of applications per applicant.

From table 4.4 it is possible to calculate that overall, between 2001 (a historic low point) and 2006, total numbers of applicants across science subjects have risen by 10% in England and by 216% in Scotland (due to more institutions joining the GTTR), but they have dropped by 3.3% in Wales. Looking at applicants to mathematics PGCE/PGDE courses, Scotland has experienced the most dramatic increase in the period 2001–2006, with applicants rising by a massive 507%; in England numbers of applicants to mathematics PGCE courses have risen overall by 47% over this period, and in Wales they have increased overall by 19% (though they actually rose by 35% between 2001 and 2004).

At a finer level of detail, certain patterns and differences across the nations emerge. These are best considered on a subject-by-subject basis.

Biology

With the exception of 2006, biology PGCE courses have consistently attracted more applicants across England than any other science PGCE course, but the gap has been closing as numbers of applicants to biology PGCE courses in England have fallen by 12% between 2001 and 2006. In Wales, a similar pattern is observed, with applicant numbers falling 22% from 117 in 2001 to 91 in 2006. In Scotland, though, a very different picture is apparent, with numbers of applicants to biology PGCE/PGDE courses trebling from 2001 to 2006.

Chemistry

In England, numbers of applicants to PGCE courses in chemistry have fluctuated, recovering from a low of 707 in 2003 to 767 in 2005, before falling back in 2006 to almost exactly the same level as was recorded in 2001. In Wales, applicants to chemistry PGCE courses have stayed reasonably steady throughout, recovering from a five-year low in 2005. But in Scotland, applicants have almost quadrupled since 2001.

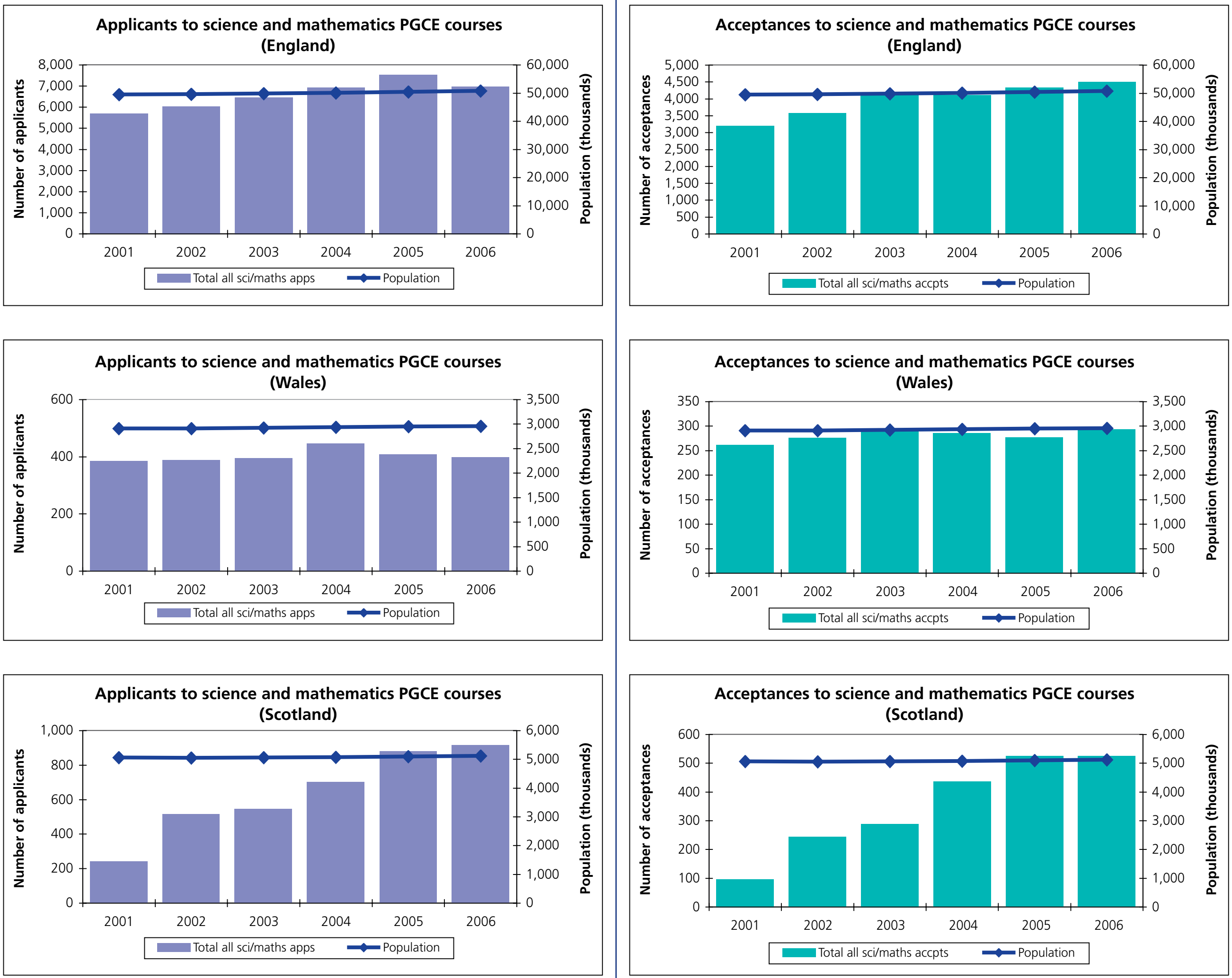
Table 4.4 Applicants and acceptances to science and mathematics PGCE courses across England, Wales and Scotland (2001–2006)[a]

Subject	Year						
England		2001	2002	2003	2004	2005	2006
Biology	Applicants	1,673	1,601	1,537	1,511	1,560	1,466
	Acceptances	848	904	919	845	862	903
Chemistry	Applicants	725	761	707	745	767	726
	Acceptances	409	443	456	442	434	472
Physics	Applicants	343	425	479	512	520	492
	Acceptances	206	250	316	300	301	303
Combined/ General Sciences	Applicants	1,033	996	1,114	1,243	1,436	1,474
	Acceptances	636	662	792	851	958	1,050
Mathematics	Applicants	1,917	2,249	2,614	2,918	3,254	2,820
	Acceptances	1,099	1,321	1,663	1,674	1,778	1,775
Wales		2001	2002	2003	2004	2005	2006
Biology	Applicants	117	97	88	99	84	91
	Acceptances	71	61	67	66	61	76
Chemistry	Applicants	43	34	35	43	30	39
	Acceptances	34	38	38	36	33	38
Physics	Applicants	29	30	32	33	28	32
	Acceptances	20	28	36	35	29	27
Combined/ General Sciences	Applicants	82	95	96	118	113	100
	Acceptances	53	54	56	51	54	54
Mathematics	Applicants	114	132	144	154	154	136
	Acceptances	83	95	97	97	100	98
Scotland		2001	2002	2003	2004	2005	2006
Biology	Applicants	119	201	180	224	280	305
	Acceptances	36	53	24	43	73	58
Chemistry	Applicants	42	83	110	100	155	167
	Acceptances	18	29	57	67	108	124
Physics	Applicants	23	68	74	93	119	116
	Acceptances	10	49	63	72	98	86
Combined/ General Sciences	Applicants	2	0	0	0	0	0
	Acceptances	0	0	0	0	0	0
Mathematics	Applicants	54	164	179	283	326	328
	Acceptances	32	112	144	253	246	256

Sources: GTTR, RS database. GTTR data exclude information on ITT provision by The Open University, the University of Paisley and certain SCITTs centres.

a The data in this table were recorded in September, right at the end of the recruitment round. Consequently they do not take account of later clearance decisions. HEFCEW final data show that for the year 2002/03, the total number of students recorded as starting these courses was as follows: Biology (58); Chemistry (37); Physics (31); Combined Sciences (53); Mathematics (103) – see http://194.81.48.132/BusinessCommunity_Docs/W0565HE_ITT_Perf_Info_2005_booklet.pdf

Figure 4.3 Applicants and acceptances to science and mathematics PGCE courses across England, Wales and Scotland in relation to the populations of these countries (2001–2006)



Sources: GTTR, RS database; ONS.

Physics

In England, despite a 5% fall between 2005 and 2006, the numbers of applicants to physics PGCE courses have risen overall by 43% from 2001 to 2006. In Wales, the numbers of physics PGCE applicants have stayed steady, while in Scotland the numbers of applicants to PGCE/ PGDE physics courses have steadily increased since 2001 and albeit from a very low base have risen by an impressive 404% from 2001 to 2006.

Combined/general sciences

Applicants to combined science PGCE courses in England have overtaken those for biology, making it the most popular science PGCE. This has been explained by providers being squeezed by reduced funding, forcing them to offer 'general science' courses instead of separate science PGCE options.[44] In Wales, despite fluctuations, combined science has been the most popular choice of science PGCE since 2003. Overall, England and Wales have experienced increases of 43%

44 *Op. cit.*, note 42.

and 22% from 2001 to 2006. In Scotland, there has been no combined/general sciences provision, reflecting the fact that the Scottish ITT providers do not offer this option.

Mathematics

Between 2001 and 2006, numbers of applicants to mathematics PGCE/PGDE courses rose across England, Scotland and Wales, by 47%, 19% and 507% respectively, although between 2005 and 2006 there was a fall of 13% and 12% in applicants in England and Wales, respectively.

In order to put these numbers into context and assess the extent to which either applicants or acceptances seem to be demand-led, figure 4.3 shows acceptances in table 4.4 normalised against the total populations of each country (see table A4.6). Comparisons across countries are made more difficult by scaling considerations, given the fact that England's population is more than an order of magnitude greater than that of both Wales and Scotland. Nonetheless, consideration of this population-normalised perspective shows:

i. that the rise in numbers of applicants and acceptances to science and mathematics PGCE courses in England has been occurring proportionately more quickly in relation to England's increasing population;

ii. that the relatively large increases in applicants and acceptances to science and mathematics PGCE courses in Scotland have occurred against a background of population stasis; and

iii. that while, in Wales, the population has continued to rise, applicants and acceptances have fluctuated. (Note: these data were collected right at the end of the recruitment round, in September, prior to final adjustments being made.)

It is clear from this analysis that the pattern of change in applicants varies distinctly from country to country. This doubtless reflects the interaction of a whole range of parameters, including in addition to population size (particularly, the population of 5–19 year olds), confidence in the economy, numbers of providers, size of allocations and the recruitment strategies of the Government and Scottish and Welsh Assemblies.

In particular, the situation in Scotland stands out as differing markedly from that observed in England and Wales. The fact that there is no combined/general sciences provision in Scotland may well be in part responsible for boosting levels of applicants to other science courses, but equally more PGDE places have been made available to help meet the Partnership for a Better Scotland general commitment to creating a teaching workforce of 53,000 by August 2007 (Mal Cooke, Scottish Executive, personal communication, 1 May 2007).

By contrast, in Wales, it is possible that the fall-off in applicants since 2004 has been caused by closures of provider institutions, and the fact that the number of maintained secondary schools has dropped slightly in recent years, from 230 in 1991 to 224 in 2006. Indeed, following a major review of ITT provision in Wales, the Welsh Assembly has committed to reducing both the number of ITT providers and its secondary teacher training provision in line with expected falls in secondary rolls, so that by 2010/11 secondary provision will have fallen by 25% in comparison with the 2004/05 figures.[45]

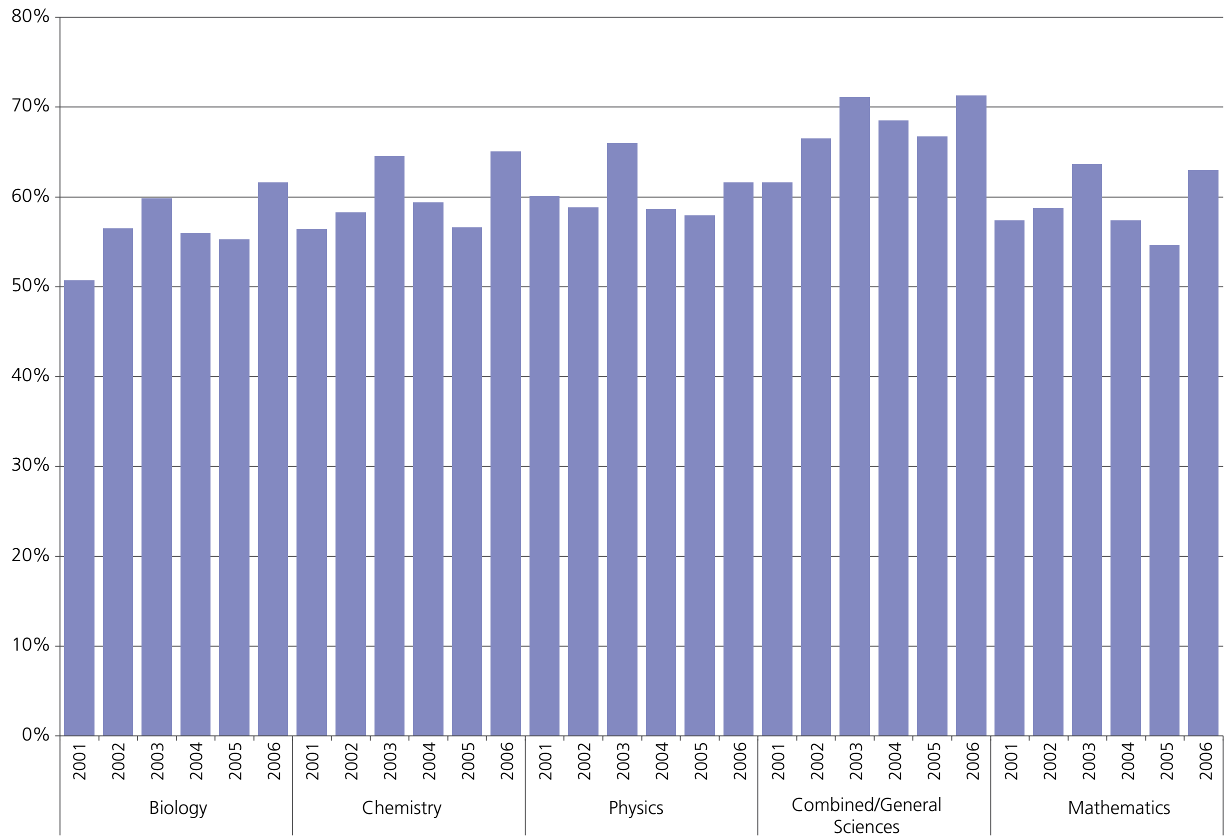
The decline in numbers of applicants to PGCE courses in science and mathematics in England between 2005 and 2006 may be indicative of a newly emerging trend. At 30 July 2007, just two months away from the end of the 2007/08 recruitment round, applicants to biology, chemistry, physics, combined sciences and mathematics PGCE courses in England were, respectively, 14.4%, 9%, 7.3%, 2.7% and 11% below the comparable figure for the same point in 2006. These overall falls may indicate that recruitment in these shortage subjects has peaked and that the 'golden hellos', which may well have been largely responsible for generating the increases in applicants noted during 2001–2005, no longer have the same pulling power as previously (see also chapter 8).

4.9 Acceptances relative to applicants to science and mathematics PGCE courses

Comparing acceptances to applicants in PGCE courses in science and mathematics across the UK, it is notable that the percentage of acceptances for all five courses is around 60% (figure 4.4), although the percentage accepted to combined/general sciences PGCE courses tends to be rather greater than that for the other sciences. The extent to which the pattern observed here reflects on (i) course allocations or (ii) the quality of applicants cannot be determined, and would require additional investigation.

45 Furlong, J, Hagger, H, Butcher, C & Howson, J 2006 *Review of initial teacher training provision in Wales. A report to the Welsh Assembly Government*. Oxford: OUDES.

Figure 4.4 Acceptances as a proportion of applicants to PGCE courses in science and mathematics across the UK (2001–2006)



Sources: GTTR, RS database.

In England, which attracts the majority of applicants, acceptances remain relatively steady. However, the data in table 4.4 show that while the number of applicants dipped in biology, chemistry and physics in 2006, the number of acceptances to PGCE courses in these subjects increased. Coinciding with the introduction of additional financial incentives paid to providers for filling their shortage-subject allocations, it is possible that this observation is because providers have been accepting candidates they might otherwise have rejected.

By contrast, in Scotland and Wales, which attract fewer applicants, the number of acceptances fluctuates more widely. Scotland's ITT setup was altered after 2001, but the increase in physics and chemistry applicants and acceptances (along with some other subjects) is the result of more PGDE places being made available to help meet the Partnership for a Better Scotland general commitment to creating a workforce of 53,000 by August 2007. The dip in biology in 2004 is likely to have resulted from the redesign of priority subjects to give a better sense of differentiation of where recruitment needs lie. In previous years there was a straight priority/non-priority split of subjects with intakes expected in priority subjects to lie between 60 and 70% of the total allocation for PGDE secondary courses. Biology was a non-priority subject, but in reality probably took a large part of the PGDE allocation. The change into a three-tier categorisation system was made in 2003–04 to try to improve the match between student intakes and vacancies. Biology was placed as the lowest category, where intake was limited to 20%.

For 2006 the proportion of combined/general science applicants as a total of all science applicants is higher in Wales than in England or Scotland (where it is negligible), but the 'conversion' rate of applicants into acceptances in this subject is lower than in England. The latest *Annual Statistics Digest* published by the General Teaching Council for Wales indicates that slightly more than one-third of registered science teachers in Wales undertook their training in combined/general science.

Table 4.5 Applications and entrants to science and mathematics PGCE courses compared with PGCE allocations at Queen's University Belfast (1999/00–2005/06)

	1999/2000			2000/01			2001/02			2002/03		
	Quota	Apps	Intake	Quota	Apps	Intake	Quota	Apps	Intake	Quota	Apps	Intake
Total Science	40		32	48		48	48		45	45		51
Biology		114	20		101	26		84	24		75	29
Chemistry		31	8		31	13		35	14		38	16
Physics		16	4		16	9		10	6		14	6
Mathematics	35	59	29	33	72	33	39	67	31	40	91	39

	2003/04			2004/05			2005/06		
	Quota	Apps	Intake	Quota	Apps	Intake	Quota	Apps	Intake
Total Science	45		47	48		47	53		48
Biology		57	23		74	24	24	62	24
Chemistry		33	14		30	13	16	31	15
Physics		25	10		24	10	11	25	9
Mathematics	40	95	39	42	103	40	47	100	42

Source: Queen's University Belfast.

4.10 Applications and acceptances to PGCE courses in science and mathematics: Northern Ireland

Although teacher training via PGCE in Northern Ireland is offered at five institutions, science and mathematics PGCE courses are only available at Queen's University Belfast (QUB).[46] Here the Graduate School of Education offers PGCE courses in biology, chemistry, physics, ICT and mathematics. Table 4.5 compares the numbers of applications to the number of entrants to these courses at QUB.

Table 4.5 shows that in Northern Ireland biology and mathematics PGCE courses consistently attract the most applications; physics attracts the fewest (about one-fifth of the number of biology applications). This situation broadly reflects that across England, Scotland and Wales (cf. table 4.4).

The numbers of applications to most subjects have declined, though it is clear that the number of applications across all subjects is consistently higher than the number of places available. However, while quotas have generally speaking been filled, and even occasionally exceeded, this is not consistently the case.

46 The University of Ulster offers a PGCE in Technology and Design and both Stranmillis University College and St Mary's University College offer a BEd in Technology and Design.

4.11 Applications and acceptances to PGCE courses in science and mathematics: data from The Open University

The Open University (OU) offers a flexible PGCE pathway over 1–3 years, in mathematics or science (the latter being the apparent equivalent of combined science PGCE courses and including aspects of biology, chemistry and physics). Cumulative data (table 4.6) for 2001–2006 reveal that during this period there were around four times as many applications to science and mathematics flexible PGCE courses as there were acceptances.

Table 4.6 Total numbers of applications and acceptances to The Open University's flexible PGCE courses in science and mathematics (2001–2006)

Subject	Applications	Acceptances
Science	1,683	421
Mathematics	1,394	324

Source: The Open University.

Table 4.7 Recruitment across all subjects via employment-based courses (England) (1999/2000–2006/07)

	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07[a]
Graduate Teacher Programme	420	860	2,010	2,540	3,370	3,510	3,550	2,650
Registered Teacher Programme	20	20	60	70	60	80	60	20
Overseas Trained Teacher Programme		80	440	510	710	970	750	260
Teach First					160	180	170	220

Sources: DfES, RS database.

a Autumn term only.

Table 4.8 Recruitment across employment-based courses in science and mathematics (England) (1999/2000–2006/07)

	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07[a]
All secondary	440	960	2,510	3,120	4,300	4,740	4,530	3,150
Mathematics	70	120	300	390	570	560	520	290
Science	60	170	460	520	660	750	660	400

Sources: DfES, RS database.

a Autumn term only.

4.12 Recruitment into science and mathematics ITT via employment-based routes

In its statistical reports, the DCSF recognises four employment-based routes into teaching.

i. Graduate Teacher Programme: involves between three months and one academic year's worth of on-the-job training for graduates, depending on experience.

ii. Registered Teacher Programme: provides on-the-job training in schools for up to 2 years for unqualified teachers who have successfully completed 2 years of a higher education course and wish to gain qualified teacher status (QTS) in the course of finishing their degree.

iii. Overseas Trained Teacher Programme: for degree-holding teachers who qualified as teachers abroad, this programme allows up to 4 years in which to gain QTS.

iv. Teach First: a 2 year programme for high-calibre graduates that provides teacher training in challenging secondary schools as well as leadership training and additional work experience outside of teaching.

Tables 4.7 and 4.8 provide an overview of recruitment into teaching by employment-based routes (EBRs) in England. EBR places are not allocated by subject, but as well as total priority subject and non-priority subject.

Nonetheless, providers are offered financial incentives to encourage them to focus recruitment especially in mathematics, physics and chemistry. They are also

Table 4.9 Disaggregated recruitment in science and mathematics through employment-based routes (England) (2005/06–2006/07)

Subject	2005/06	2006/07
Biology	–	50
Chemistry	–	39
Physics	–	30
General sciences	277	251
Applied science	1	–
Mathematics	197	241
Grand total	**475**	**611**

Source: TDA (by permission).

Table 4.10 Number gaining QTS by the overseas trained teacher programme (OTTP) in science and mathematics (England, 2004/05)				
QTS main subject	Non-EU countries	Other EU countries	UK	Grand Total
Combined/General Sciences	148	1	2	**151**
Mathematics	119	0	4	**123**
Total	267	1	6	**274**
Total number of OTTP recorded in 2004/05				**940**[a]

Source: TDA (by permission).

a Source: http://www.dfes.gov.uk/rsgateway/DB/VOL/v000633/Additionala.xls#'A2'!A1

free to adjust their allocation to meet local needs. As a result, table 4.8 shows that numbers undergoing science-based secondary school employment-based training in England have, generally speaking, been growing.

Although disaggregated figures for recruitment into the separate sciences through EBRs are not normally available, they have been sourced from the TDA for the past 2 years and are presented in table 4.9. In 2006, the DfES began to publicly identify the specialist subject of trainees registering on initial teacher training courses and accordingly the TDA has followed suit.

The data in table 4.9 show in particular that employment-based routes into ITT in science are skewed towards general sciences training, with separate sciences accounting for approximately one-third (32%) of all science acceptances in 2006/07. This contrasts with the situation for conventional ITT presented in table 4.4, from which it is calculable that 61% of the 2,990 acceptances in science were in the separate sciences. More significantly, perhaps, it is apparent from further comparison of these two tables that in 2005/06 employment-based routes contributed just 10% of all science teacher trainees recruited, and only 11% of all mathematics teacher trainees.

4.13 Recruitment of science and mathematics teachers from overseas

Table 4.10 shows the numbers of those gaining QTS in science and mathematics in England via the Overseas Trained Teacher Programme (OTTP) and their geographical origin.[47] It shows that the majority of people gaining QTS on the OTTP come from outside the EU, and that of those recorded on the programme 16% were science teachers and 13% were mathematics teachers. Unfortunately, disaggregated data by science specialism appear to be unavailable.

Wealthy countries will often try to recruit overseas trained teachers in times of shortage, and recent years have witnessed increasing numbers of overseas trained teachers being employed in UK schools, with the majority of these being located in London and the South East (McNamara *et al*. 2005).[48] In analysing data from the Teacher Training Agency (now the TDA), these researchers found that between January 2001 and March 2004 the greatest proportions of subject specialisms among overseas trained teachers were found to be in 'primary – no specialism' (24%, n = 649); English (18%, n = 485); mathematics (13%, n = 356); and science (13%, n = 345), and that numbers of these teachers had been increasing during this period (table 4.11). Corroborative evidence for increased recruitment in the shortage subjects of science and mathematics came from a sampling of 44 NASUWT Local Association Secretaries (LASs), 33 of which provided information on the perceived subject specialisms of overseas trained teachers employed in secondary schools. Among the 33 LASs who provided such information, mathematics and science were the specialisms most frequently reported.

The NFER (2006) report included data from a sample of 618 heads of mathematics departments, a coverage equivalent to one in five maintained secondary schools in England, which showed that one-fifth (20%) of these departments employed teachers who had

47 The TDA is unable to break the data down any further.

48 McNamara, O, Lewis, S & Howson, J 2005 *The recruitment of overseas trained teachers*. Research report conducted on behalf of NASUWT. Birmingham: NASUWT.

Table 4.11 Subject specialisms of overseas trained teachers assessed for UK qualified teacher status by the Teacher Training Agency between 2001 and March 2004

Subject	2001	2002	2003	2004 (January–March)	Total
Primary – no specialism	11	57	413	168	649
English	108	198	136	43	485
Mathematics	82	102	130	42	356
Science	59	111	124	51	345
Grand total (primary and secondary)	**481**	**734**	**1,067**	**427**	**2,709**

Source: Adapted from McNamara *et al*. (2005), Appendix 14.

trained overseas.[49] Most of these (62%) employed just one overseas trained teacher, while some reported having as many as six overseas teachers. Similarly, the NFER found from 630 science departmental heads, equivalent to one in five maintained secondary schools in England, that 3% of teachers in these departments had trained overseas. Assuming, given the percentage of mathematics departments with one overseas teacher, that no science or mathematics department has more than one overseas trained teacher, it appears that there were higher proportions of overseas mathematics teachers than overseas science teachers (of the order of 6:1), with around 600 overseas trained mathematics teachers to 100 overseas trained science teachers employed by secondary maintained schools in England in 2004/05, the year that research for this study was undertaken. Nonetheless, this estimate may not indicate the true situation as it does not take account of factors such as differences in school size and regional effects.

4.14 Gender of applicants and recruits into ITT

The gender balance of the workforce is considered by many to have a significant impact on learning and even be an important influence on pupil career choice. For instance, at primary level, recent TDA research found that two in five boys (39%) in English primary schools were not being taught by a male teacher, yet the presence of male teachers was associated with better behaviour, harder work, a more enjoyable school experience and greater self-confidence among boys.[50] Further, a recent Scottish study found from a literature review that the reasons for the 'feminisation of the teaching workforce include the continuation of gendered subject choices at an early age which lead to the reproduction of traditional expectations of future careers'.[51]

This section investigates the gender balance among applicants to primary PGCE courses and to science and mathematics secondary PGCE courses across England, Wales and Scotland.

4.14.1 Gender balance among primary PGCE course applicants

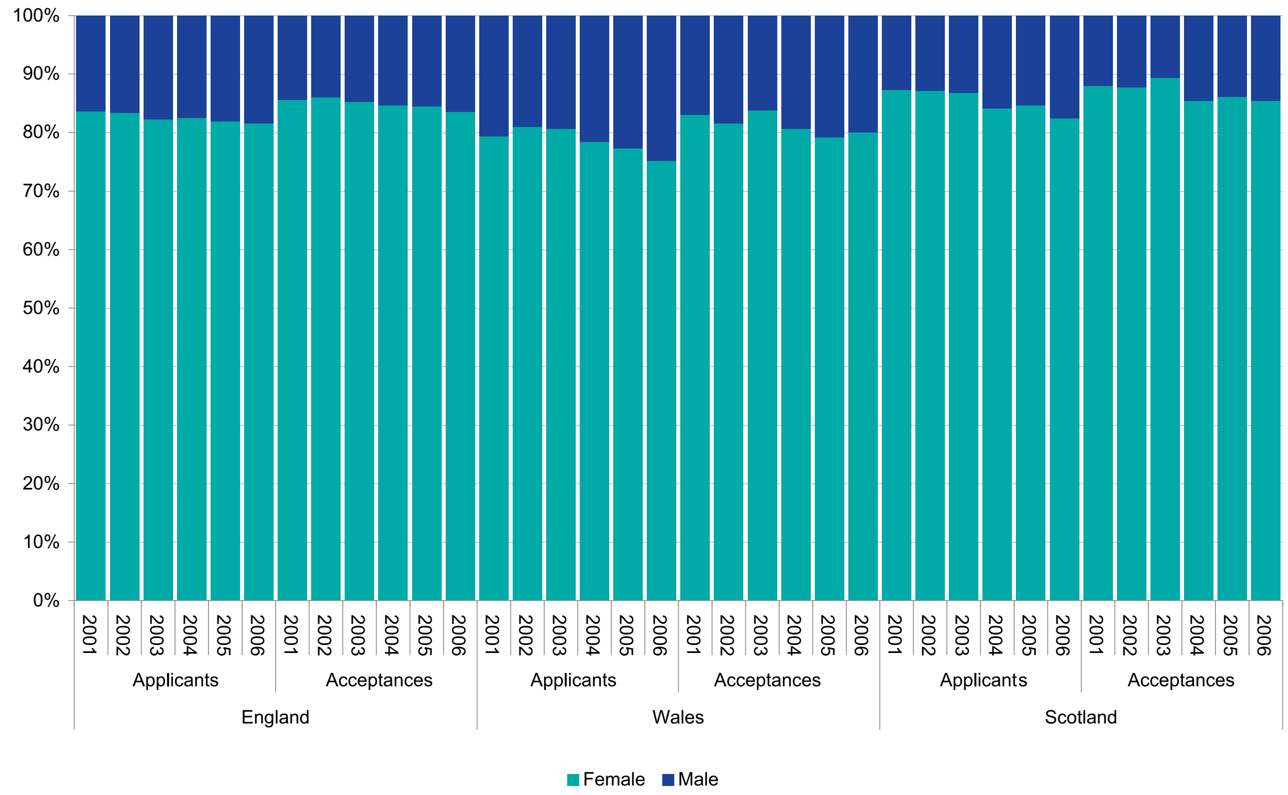
According to GTTR figures for 2001–2006 (table A4.7), females comprise the great majority of primary PGCE applicants across England, Wales and Scotland. This is illustrated by figure 4.5 (a breakdown of the data in table 4.4, *viz*. table A4.7), which shows that during this period, female applicants consistently accounted for more than 70% of all primary PGCE course applicants. This figure also shows a similar pattern for acceptances with, if anything, the bias becoming slightly more accentuated. In fact, further exploration of the data reveals that during this period, across England, Wales and Scotland, the proportion of female acceptances has consistently exceeded that of male acceptances, compounding the imbalance already evident in the applicant statistics (figure 4.6).

49 *Op. cit*., note 10.

50 Research conducted by the TDA, published in July 2007 (see http://www.tda.gov.uk/about/mediarelations/2007/20070731.aspx).

51 Riddell, S, Tett, L, Burns, C, Ducklin, A, Ferrie, J, Stafford, A & Winterton, M 2005 *Gender balance of the teaching workforce in publicly funded schools*, p. 5. Edinburgh: The Moray House School of Education.

Figure 4.5 Applicants and acceptances by gender to primary PGCE courses across England, Wales and Scotland (2001–2006)



Sources: GTTR, RS database.

4.14.2 Gender balance among secondary PGCE science and mathematics applicants

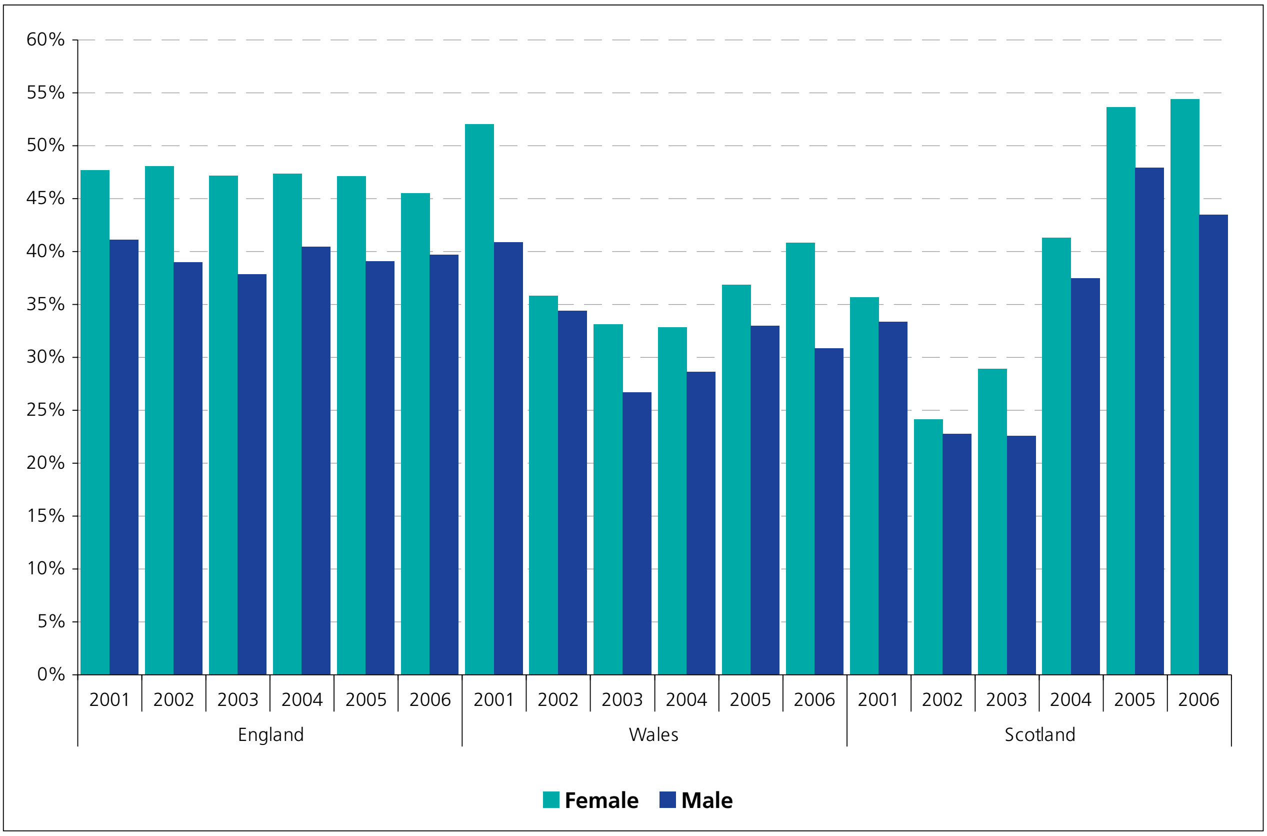
Although generally there are concerns among some that the workforce is becoming increasingly female-biased, in physics there is concern over the predominance of male teachers – specifically that this may lead to fewer girls pursuing science (particularly physics) at A-level and beyond, thereby perpetuating the historical precedent in physics A-level and PGCE take-up described in tables A4.8 and A4.9.

Evidence suggests that girls and boys are affected differently by the gender of their teachers. Boys receive more attention than girls in science lessons generally, whatever the sex of their teachers, although the impact of this on performance in national science tests has not been quantified.[52] However, as Murphy & Whitelegg (2006) also show, girls may see science as not being especially relevant to them, or perceive it as difficult, and A-level physics teachers may expect girls to find particular topics difficult. Without doubt, however, as table A4.8 shows, girls consistently account for only around 20% of all physics A-level entries in England.

At secondary level, too, numbers of female applicants to science PGCE courses exceed those of male applicants. In England, from 2001 to 2006, female applicants always accounted for more than half of all applicants across biology, chemistry, physics and combined/general sciences (table A4.9). Further, a still greater proportion of females were accepted in each of these years to PGCE courses in these subjects. A similar pattern of applicants is evident across Scotland and in Wales during this time-period (except in 2002, when, as Table A4.10 shows, the proportion of female applicants to PGCE courses in these subjects was 45%).

52 Murphy, P & Whitelegg, E 2006 *Girls in the physics classroom. A review of the research on the participation of girls in physics*. London: Institute of Physics.

Figure 4.6 Acceptances to primary PGCE courses across England, Wales and Scotland, as a percentage of applicants (2001–2006)



Sources: GTTR, RS database.

Again, with the exception of 2002 and 2005 in Wales, female acceptances exceeded those of male acceptances in these subjects across Wales and Scotland.

Looking more closely at the gender balance of applicants and acceptances to each of these subjects across England, Wales and Scotland, it is possible to see that females are generally responsible for the majority of applicants to science PGCE courses, with the notable exception of physics (figures 4.7–4.10, table A4.9). Equally, it may be seen that the female bias generally observable in applicants to biology, chemistry and combined/general sciences PGCE courses is more often than not accentuated in the number of acceptances. Even when fewer female than male applicants were recorded, as was the case for combined/general sciences PGCE courses in Wales in 2002, chemistry in Wales in 2004, and chemistry in Scotland in 2002, there were more females than male acceptances, though the absolute numbers involved in each instance are small.

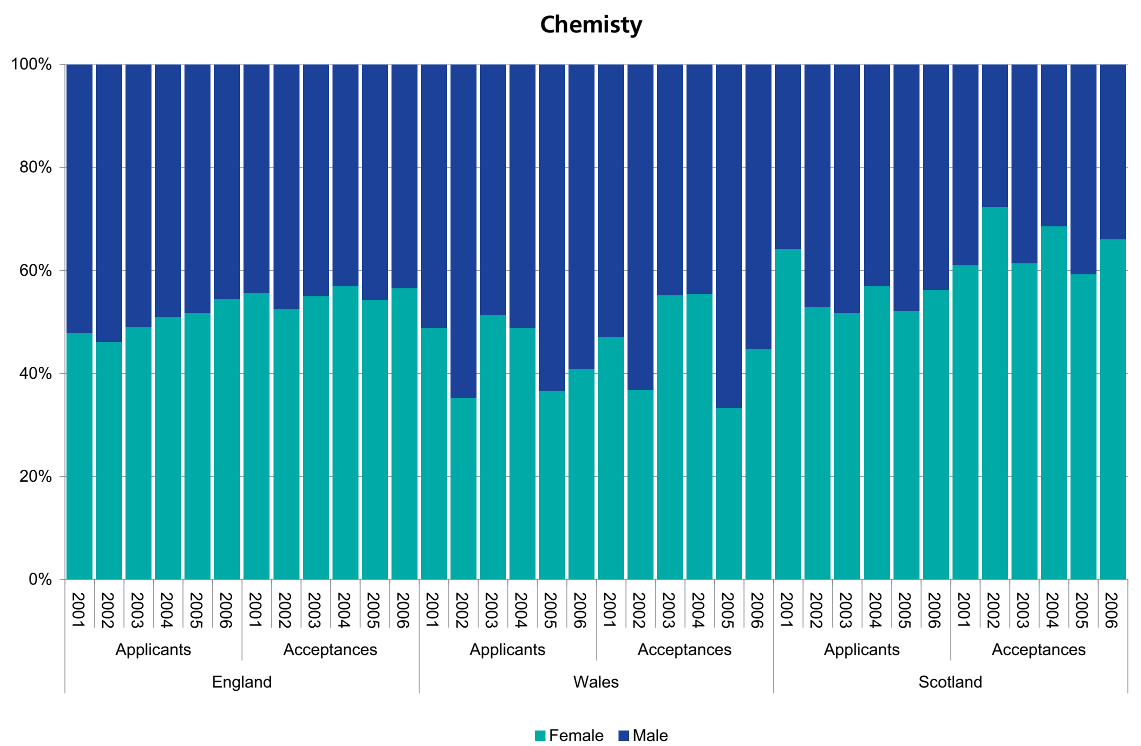
In physics, however, there are consistently more male applicants and more male acceptances across England, Wales and Scotland, with male applicants and acceptances frequently accounting for more than two-thirds of both.

In mathematics (figure 4.11 and table A4.11) males account for more than half of all PGCE course applicants across England, Wales and Scotland. Generally, too, more males than females are accepted on to these courses. Although the proportion of male acceptances is, with the exception of Scotland, less than that in England.

Figure 4.7 Comparison of the relative proportion of male and female applicants and acceptances to biology PGCE courses across England, Wales and Scotland (2001–2006)

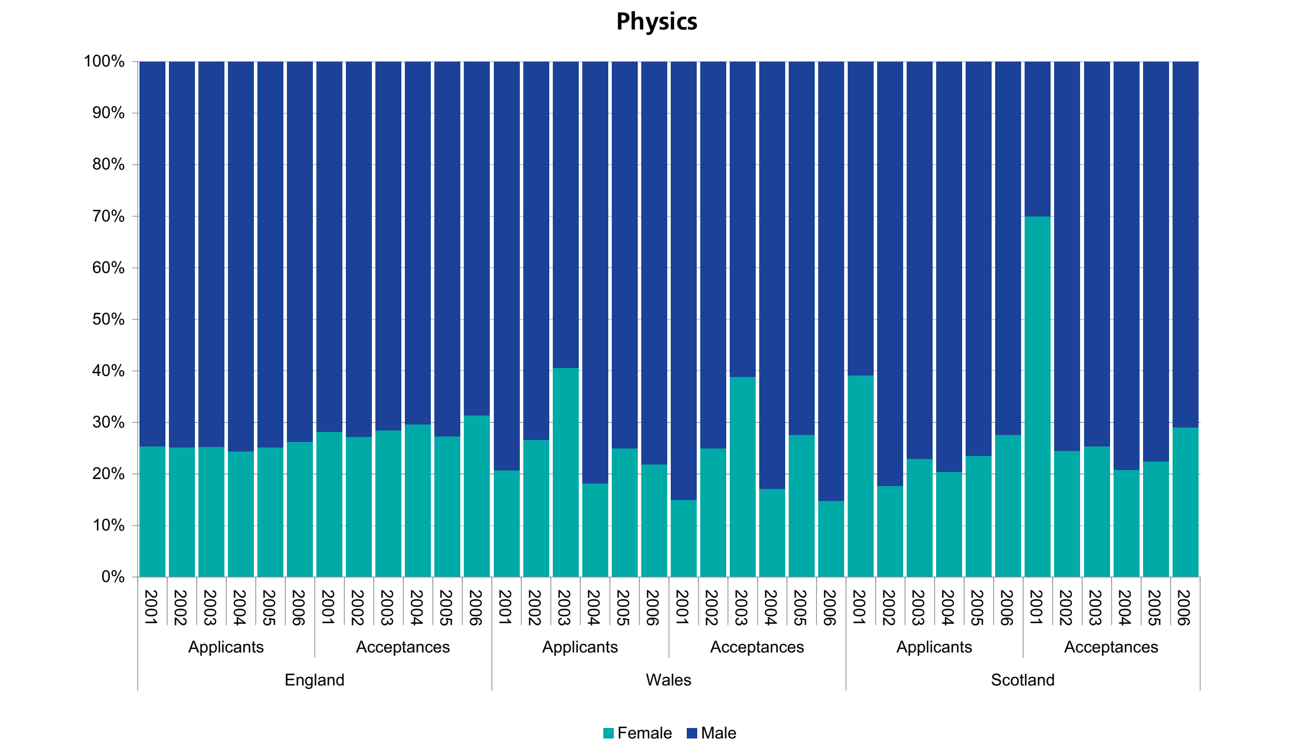
Sources: GTTR, RS database.

Figure 4.8 Comparison of the relative proportion of male and female applicants and acceptances to chemistry PGCE courses across England, Wales and Scotland (2001–2006)



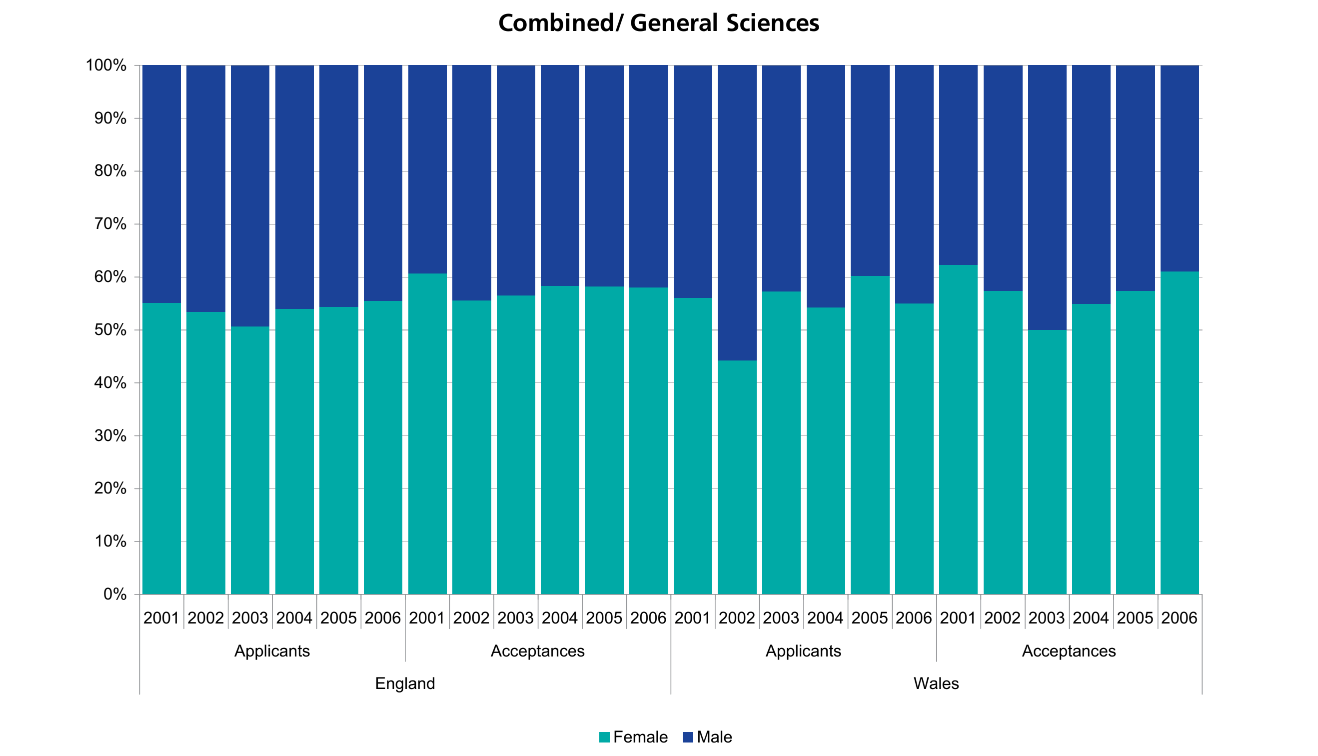
Sources: GTTR, RS database.

Figure 4.9 Comparison of the relative proportion of male and female applicants and acceptances to physics PGCE courses across England, Wales and Scotland (2001–2006)



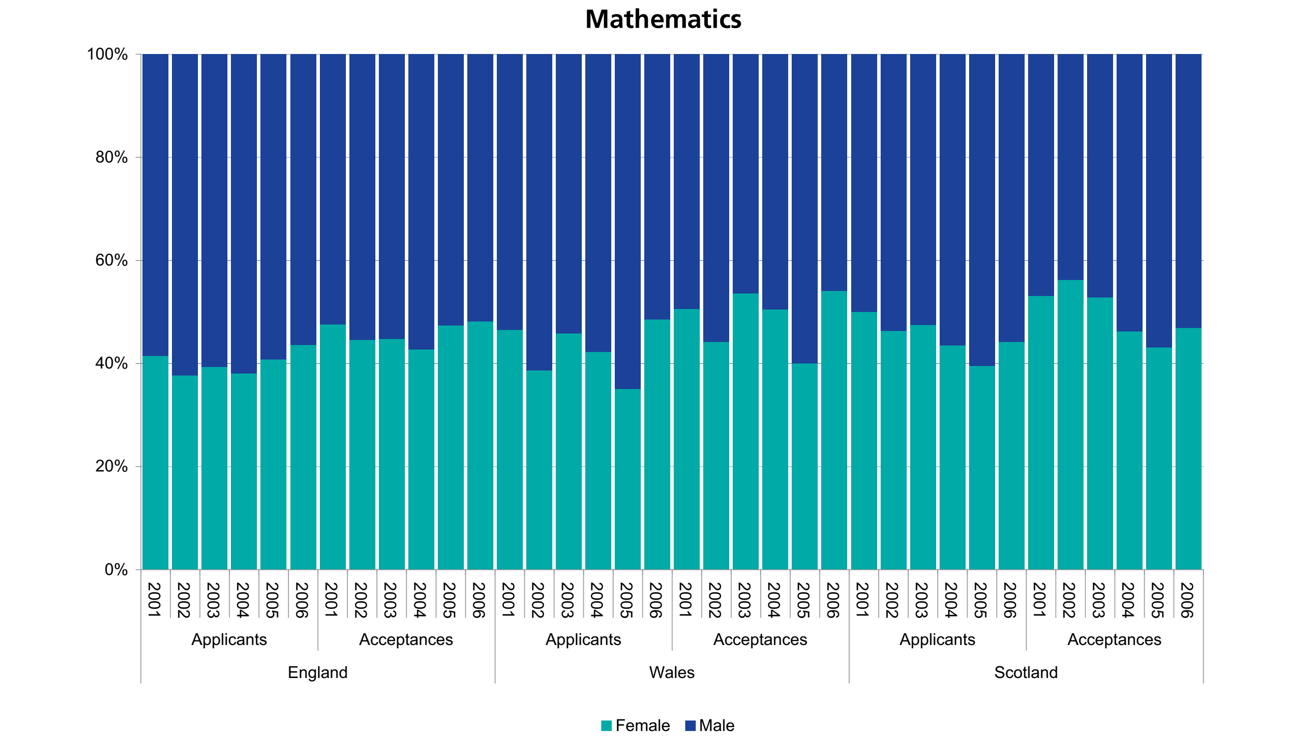
Sources: GTTR, RS database.

Figure 4.10 Comparison of the relative proportion of male and female applicants and acceptances to combined/general sciences PGCE courses across England and Wales (2001–2006)



Sources: GTTR, RS database.

Figure 4.11 Comparison of the relative proportion of male and female applicants and acceptances to mathematics PGCE courses across England, Wales and Scotland (2001–2006)



Sources: GTTR, RS database.

4.14.3 Patterns of PGCE applicants in respect of A-level choice and graduate qualifications

As table 4.12 shows, the popularity of science and mathematics PGCE courses closely approximates to A-level entry trends in these subjects. This observation holds despite (i) direct comparisons across the same year not being possible (although those taking A-levels in 2001 could conceivably be among those who applied to take PGCE courses in 2005 or 2006), and (ii) the fact that GTTR statistics show that about three-quarters (as opposed to 100%) of PGCE applicants are made by people in their twenties.

For example, in England the ratio of male-to-female physics PGCE applicants (approximately 70:30) is similar to that of the ratio of male-to-female A-level physics entries. These ratios also happen to be consistent with those of male-to-female physics first-degree UK-domiciled graduates in 1994/95 and 2004/05 (Royal Society 2006).[53]

The similarity in the gender ratios of PGCE applicants and A-level entries over time is notable. Unfortunately, DCSF data on the gender of subject-specialist teachers do not discriminate between primary and secondary schools. This means that it is not possible to shed any light on whether the gender of science and mathematics teachers in England is a lesser (or greater) factor in influencing subject choice than other factors (cf. § 4.14.2).

4.15 Quality of recruits into ITT

So far we have concentrated on numbers of applicants and acceptances onto PGCE courses. However, it is just as important to recruit good quality candidates to become teachers as it is to recruit enough of them. While we do have targets measuring how well England is performing against the latter, albeit that their provenance is uncertain, the question of quality is more problematic and not addressed within Government statistics.

53 *Op. cit.*, note 34, figure 5.11, p. 37.

Subject	Year	PGCE applicants				A-levels			
		Female	%	Male	%	Female	%	Male	%
Biology	**2001**	1,051	*63*	622	*37*	27,567	*61.8*	17,025	*38.2*
	2002	1,007	*63*	594	*37*	27,978	*61.6*	17,429	*38.4*
	2003	939	*61*	598	*39*	26,882	*61.2*	17,020	*38.8*
	2004	979	*65*	532	*35*	26,615	*60.2*	17,620	*39.8*
	2005	971	*62*	589	*38*	26,981	*59.1*	18,681	*40.9*
	2006	948	*65*	518	*35*	27,324	*58.6*	19,300	*41.4*
Chemistry	**2001**	348	*48*	377	*52*	16,747	*49.4*	17,124	*50.6*
	2002	352	*46*	409	*54*	16,392	*50.7*	15,932	*49.3*
	2003	347	*49*	360	*51*	15,941	*51.3*	15,124	*48.7*
	2004	380	*51*	365	*49*	16,289	*50.7*	15,841	*49.3*
	2005	398	*52*	369	*48*	16,380	*49.4*	16,784	*50.6*
	2006	396	*55*	330	*45*	16,814	*48.7*	17,720	*51.3*
Physics	**2001**	87	*25*	256	*75*	6,021	*21.5*	22,010	*78.5*
	2002	107	*25*	318	*75*	6,319	*22.7*	21,541	*77.3*
	2003	121	*25*	358	*75*	5,908	*22.5*	20,370	*77.5*
	2004	125	*24*	387	*76*	5,383	*21.9*	19,223	*78.1*
	2005	131	*25*	389	*75*	5,174	*21.5*	18,920	*78.5*
	2006	129	*26*	363	*74*	4,970	*21.0*	18,687	*79.0*
Mathematics	**2001**	794	*41*	1,123	*59*	20,254	*37.4*	33,903	*62.6*
	2002	847	*38*	1,402	*62*	16,381	*37.1*	27,775	*62.9*
	2003	1,029	*39*	1,585	*61*	16,753	*37.7*	27,700	*62.3*
	2004	1,111	*38*	1,807	*62*	17,638	*38.3*	28,379	*61.7*
	2005	1,326	*41*	1,928	*59*	17,423	*37.8*	28,611	*62.2*
	2006	1,229	*44*	1,591	*56*	19,168	*38.5*	30,637	*61.5*

Table 4.12 PGCE applicants compared with A-level entries (England) (2001–2006)

Sources: GTTR, DfES (SFR02/2007), RS database. A-levels are 'Biological sciences'.

4.16 Quality of ITT providers

The Office for Standards in Education (Ofsted) is responsible for inspecting the quality of ITT providers, which it measures at secondary level through a combination of assessment of the management and quality assurance of the whole provision, overall quality of an institution's training programme and the standards of trainees' teaching towards the end of their training.[54] On the basis of this assessment, it categorises institutions as 'good' (A or B), 'satisfactory' (C), or 'inadequate' (D). Ofsted inspection grades are then used to help calculate ITT providers' allocation quality categories. According to the TDA's 2007 Performance Profiles, quality categories for all institutions were last measured in 2004/05.

Annex B of a recent letter on ITT place allocations reveals that 66 out of 85 ITT providers (78%) to whom place allocations in science PGCE courses were offered (including those offering PGCE courses in information technology) had been graded 'good' (9 were category A and 57 were category B) and none of the others were considered to be anything less than satisfactory (though the quality category of one provider had yet to be confirmed). Of the 84 providers of mathematics PGCE courses, 67 out of 84 (80%) had been rated good (9 were category A and 58 were category B) and none of the others were considered to be anything less

54 Ofsted 2005 *Framework for the inspection of initial teacher training for the award of qualified teacher status 2005–2011*. London: Ofsted.

Table 4.13 Degree classes of science and mathematics PGCE trainees measured against the degree classes gained by all graduates in these disciplines in 2002/03

Degree class	Physics (%)		Chemistry (%)		Biology (%)		Mathematics (%)	
	Trainee teachers	Graduates	Trainee teachers	Graduates	Trainee teachers	Graduates	Trainee teachers	Graduates
First	12.5	26.2	13.2	23.3	8.6	12.4	15.7	26.1
2.1	26.4	31.9	37.2	35.5	48.0	45.4	30.5	33.3
2.2	38.0	24.7	35.0	25.6	35.9	31.8	33.1	25.2
Third	16.7	14.5	9.1	11.4	5.5	6.6	14.7	12.5
Unclassified	6.3	2.7	5.5	4.2	2.1	3.8	6.1	2.8
Total known	**287**	**2,210**	**363**	**2,945**	**860**	**4,425**	**798**	**4,390**

Sources: TDA Performance Profiles 2005, data 2002–03, and HESA Students in Higher Education 2002–03, quoted in Smithers & Robinson (2006), p. 46.

than satisfactory (though the quality category of one provider had yet to be confirmed).[55]

An alternative means of measuring the quality of ITT providers is to survey trainees' assessments of them. A recent comprehensive survey of ITT students' experiences (across the gamut of courses and programmes offered) found that the majority of respondents (84% of 3,162) would follow the same ITT route again and over three-quarters (76% actual, 75% weighted) of respondents indicated that they would follow the same ITT route with the same ITT provider. A higher proportion of those following SCITT programmes, at both the primary and secondary phase, reported that they would follow the same route with the same provider again compared with those following other ITT routes.[56]

4.17 Quality of intake into science and mathematics teacher recruitment

One measure of quality is the degree class of applicants and entrants to ITT courses in science and mathematics. This measure gives a reliable indication of an individual's subject knowledge and expertise, but not their ability to teach (cf. chapter 1, § 1.2). Nonetheless, by comparing degree class of teacher trainees with that of other graduates, it is possible to assess the popularity of teaching among the brightest graduates.

A 'good' degree is normally classed as a first or upper second (2.1). Smithers & Robinson (2006) showed that across the sciences, fewer graduates with good degrees opted to train as teachers compared to compatriots who chose other pursuits, while higher proportions of holders of lower-class degrees went into teacher training than other science and mathematics graduates (table 4.13).[57] The situation appears worst in physics. In 2002/03, only 39% of physics graduates who chose to go into teacher training had good degrees, though 58% of the 2,210 physics graduates that year were awarded a first or a 2.1. By contrast, in biology, 57% of graduates gained good degrees, and of the 19% of those who chose to pursue teacher training, the same percentage (57%) had been awarded a good degree.

Table 4.12 shows that physics and chemistry are attracting both fewer graduates overall into teaching and more of the ostensibly lower-calibre graduates, and in some cases physics graduates are choosing to teach other subjects. Smithers & Robinson's analysis of TDA data indicated that more than a third each of physics graduates entering teacher training in 2002/03 opted to teach combined science (52 out of 150) and mathematics (55 out of 150) rather than physics and that, of the latter, 51% had first-class or 2.1 degrees, almost as many as the total proportion of physics graduates that were awarded a good degree.

55 TDA 2006 ITT place allocations letter 2006/07 and 2007/08, Annex B. 5 October 2006.

56 Hobson, A J, Malderez, A, Tracey, L, Giannakaki, M S, Pell, R G, Kerr, K., Chambers, G N., Tomlinson, P D & Roper, T 2006 Retention on ITT programmes and in the teaching profession. In *Becoming a teacher: student teachers' experiences of initial teacher training in England*, p. 51. DfES Research Report RR744. Nottingham: University of Nottingham, University of Leeds and Ipsos MORI Social Research Institute.

57 *Op. cit.*, note 42, p. 46.

Table 4.14 Postgraduate entrants into initial teacher training by class of first degree (science) (2001–2006)

Year	1st	2.1	2.2	3rd	Pass	Class not known	Degree equivalent	Non-UK degree	Total
2001	159	755	742	186	86	73	27	41	2,069
2002	160	769	708	176	105	73	23	32	2,046
2003	162	858	748	180	92	64	20	40	2,164
2004	195	876	787	165	105	45	21	76	2,272
2005	229	994	848	171	113	47	30	69	2,501
2006	243	1,002	801	197	69	58	21	87	2,478
Grand total	**1,148**	**5,254**	**4,634**	**1,075**	**570**	**360**	**142**	**345**	**13,530**

Source: TDA (By permission).

Table 4.15 Postgraduate entrants into initial teacher training by class of first degree (mathematics) (2001–2006)

Year	1st	2.1	2.2	3rd	Pass	Class not known	Degree equivalent	Non-UK degree	Total
2001	105	290	358	145	101	62	18	33	1,112
2002	102	299	318	140	94	47	19	38	1,057
2003	100	332	386	160	93	59	15	50	1,195
2004	134	396	431	153	123	57	7	51	1,352
2005	201	499	493	194	110	29	27	67	1,620
2006	202	541	565	182	101	48	13	94	1,746
Grand total	**844**	**2,357**	**2,551**	**974**	**622**	**302**	**99**	**333**	**8,082**

Source: TDA (By permission).

Trend data specially sourced from the TDA (see tables 4.14 and 4.15) show the degree class of science and mathematics graduates entering teacher training between 2001 and 2006. Table 4.14 shows that over this period, the total number of entrants in science has risen by 20%, perhaps reflecting the impact of pay incentives. In tandem with this increase has come a proportionate rise in the numbers of first-class degree holders, from 8% to 10% and of 2.1 degree holders from 36% to 40%. The proportionate numbers of 2.2 degree holders in the cohort, however, has fallen from 36% to 32% and there has been a marginal fall in the proportions of third-class degree holders from 9% to 8%. The proportion of people within a cohort entering teacher training with non-UK degrees has increased from 2% to 3.5% in this period.

Similarly, table 4.15 shows that the number of science postgraduate mathematics entrants into teacher training has risen by 57% between 2001 and 2006, and together with this, the proportion of first-class degree holders has risen from 9% to 12% and that of 2.1 degree holders has risen from 26% to 31%. The proportion of 2.2 degree holders has held steady at 32% and that of third-class degree holders has fallen from 13% to 10%.

Looking at the overall situation, in 2006 the number of science trainee teachers holding a first-class or 2.1 degree accounted for half (50%) of science postgraduate entrants, compared with 44% in 2001, while in mathematics the figure was 43%, compared with 36% in 2001. This positive trend is enhanced by concomitant falls during this period in the numbers of postgraduate entrants holding third-class or pass degrees, from 13% to 11% (science) and from 22% to 16% (mathematics). Whether this trend is a positive reflection on the efforts there have been to attract more good graduates into science and mathematics teaching is not clear and, of course, it is not possible to discern from the information presented here specialism-related effects. Further, notwithstanding the unsatisfactory use of degree-class as a proxy for teaching ability, a sobering thought is that studies across the Atlantic have shown that it is the higher-ability teachers that tend to leave the profession.[58]

Conclusions

i. The quality of data on applicants and acceptances to science and mathematics PGCE courses across the four nations of the UK is variable.

ii. Between 2001 and 2006, total numbers of applicants to PGCE courses across science subjects rose by 10% in England and 216% in Scotland, but they fell by 3% in Wales. Over the same period Scotland has experienced the largest increase in applicants to mathematics PGCE/PGDE courses, with numbers of applicants rising by 507%; in England applicants to mathematics PGCE courses have risen by 47% over this period, and in Wales they have increased by 19%.

iii. Combined science represents the biggest growth area in science initial teacher training. It is not clear whether this is demand- or supply-driven, but the uptake of this course amongst science graduates wishing to pursue teacher training is increasing.

iv. There remain a significant number of universities, some with a strong reputation in science, who either do not offer PGCE courses in the separate sciences or do not offer any ITT at all.

v. Of the providers that do offer PGCE courses in science, a significant number are only accepting small numbers of trainees. This raises concerns over the ability of these providers to remain viable.

vi. Little is known about the specialisms of those undertaking employment-based routes into teaching, making it difficult to evaluate their contribution to the recruitment of teachers in shortage subjects.

vii. Examination of gender ratios indicates that across the UK the workforce in both the primary and secondary sectors is becoming increasingly female-biased. Applicants to PGCE courses in science and mathematics generally show a female bias, with the notable exception of physics.

viii. No satisfactory measure exists across the UK to assess the quality of trainee teachers.

58 Gryphon, M 2006 Giving kids the chaff. How to find and keep the teachers we need. *Policy Analysis* no. 579. Washington, DC: Cato Institute.

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.

5 Retention of science and mathematics teachers across the UK

This chapter considers retention during and following recruitment into the workforce. This is a critical issue as it represents a potential wastage of investment by individuals, universities, schools and, more importantly, a loss of teaching talent. In its 2005/06 Annual Report Ofsted reported that 'In some schools, however, senior managers are struggling to support large numbers of new and inexperienced teachers. Problems with the recruitment and retention of teaching staff often have an adverse effect on the quality of teaching and on pupils' attitudes, behaviour and progress in these schools.'

5.1 Retention on ITT courses

Drop-out (excluding deferred completion) from teacher training may occur at three points. First, there are those who apply for teacher training and, for whatever reason, never follow through with their application; second, a proportion of those who are accepted for teacher training drop out before beginning their training; and third, there are some trainees who leave before completing their course. Table 5.1, for instance, shows that The Open University's flexible PGCE has witnessed hundreds of science and mathematics students drop out during the past six years.

More widely, analysis of the TDA's Performance Profiles reveals that drop-out rates among science and mathematics teacher trainees are, respectively, 15.7% and 17.8%, among the highest recorded for subjects that the government has designated as priority for recruitment (table 5.2).

There are many reasons behind trainees' decision to quit, or defer, their training and a recent study considering both undergraduate and postgraduate primary and secondary ITT students has found that the main reasons for doing so include inability to manage the workload, deciding to pursue a different career and lack of appropriate support.[59] This study provides useful insight into the variety of circumstances that individuals find themselves in, and of the stresses that secondary science and mathematics trainees' experience. Issues of work/life balance and salary, particularly for career changers, and general mismatch of reality to expectations, came though strongly. The following quotations from the study are representative:

Table 5.1 Total drop out from The Open University's science and mathematics flexible PGCE courses before and after acceptance (2001–2006)

	Withdrew before acceptance	Quit after acceptance	Total
Science	373	110	**483**
Mathematics	257	80	**337**

Source: The Open University.

Table 5.2 Drop-out rates during training among trainee teachers in shortage subjects (England, 2005/06)

Subject	% failing to qualify
Design and technology	18.0
Mathematics	17.8
Information technology	17.8
Modern languages	16.2
Religious education	16.2
Science	15.7
Music	13.1
English	12.6

Sources: TDA, *TES* 27 July 2007.

59 Hobson, A J, Malderez, A, Tracey, L, Giannakaki, M S, Pell, R G, Kerr, K., Chambers, G N., Tomlinson, P D & Roper, T 2006 Retention on ITT programmes and in the teaching profession. In *Becoming a teacher: student teachers' experiences of initial teacher training in England*, p. 212. DfES Research Report RR744. Nottingham: University of Nottingham, University of Leeds and Ipsos MORI Social Research Institute.

Table 5.3 'Corrected' recruitment to science and mathematics ITT courses in 2005/06 (England)						
Subject	Target	Official recruited (PGCE)	Undershoot	Drop-out (no. of trainees)	'Corrected' recruitment	'Corrected' undershoot
Science	3,225	2,890	–10%	15.7% (to 454)	2,436	–24%
Mathematics	2,350	1,920	–18%	17.8% (to 342)	1,578	–33%
Sources: DfES (see chapter 9 table 9.1); *TES* (see chapter 5, table 5.2).						

'I was working possibly harder than I had ever worked, ever, and at that point the realisation that this was not a job which would lend itself easily to a work/life balance became evident…. I think the realisation came to me that I was studying for a qualification that would allow me to do a job where I had very little respect, I would be taking a huge drop in salary and yet I was actually working harder than I would work in another profession' (Female, 45-plus, Flexible PGCE, secondary, science).[60]

'I do have three small children and that did have an impact in my choice because you sort of imagine that a career in teaching will fit in with family life more conveniently…. It's just so hard, it's such hard work to actually be a really good teacher [it] has taken a toll on my family' (Female, 45-plus, Flexible PGCE, secondary, science).[61]

'It suddenly hits you halfway through the first block, you are not going to be as good a teacher as you thought you were going to be, because there is so much to do….' And it just isn't doable, and it gets really demoralising' (Male, 40–44, PGCE, secondary, mathematics).[62]

Nonetheless, the impact of trainees failing to complete their courses is significant, monetarily in respect of the 'wasted' investment, but also materially. Given the drop-out rates reported in table 5.2, it is necessary to 'correct' the recruitment figures recorded that year (see chapter 9, table 9.1). This is shown in table 5.3 and suggests that, although the DCSF factors in a 'wastage' figure in setting its targets, this figure is lower than it needs to be.

60 *Ibid.*, p. 223.

61 *Ibid.*, p. 224.

62 *Ibid.*, p. 225.

5.2 Retention of newly qualified teachers in England and Wales

The following section considers data from England, but the reports referred to often cover both England and Wales.

In England, the DCSF publishes a range of information concerning: (i) the number of newly qualified teachers (NQTs) in service by age and gender (for both undergraduate and postgraduate routes into teaching); (ii) the number of NQTs in service by age, gender and sector (for both undergraduate and postgraduate routes into teaching) since 2002; and (iii) the number of initial teacher training completers not in service in England by age and gender. These data provide a general picture of recent trends. They show that between 2002 and 2004:

i. approximately three times more NQTs enter the profession via a postgraduate route than through an undergraduate route.

ii. the number of female NQTs in service outnumbered the number of male NQTs in service by a ratio of at least 6:1 (undergraduate route) and by about 3:1 (postgraduate route), indicating that considerably more women than men enter the profession;

iii. while the number of female NQTs entering the profession via undergraduate routes fell by 7% between 2002 and 2004, the number of women entering the profession via postgraduate routes increased during this period by 18% from 8,940 to 10,580 (a rise that may reflect the impact of the various financial incentives the Government introduced to increase the numbers of teachers).

iv. as expected, most (at least 70% of) NQTs entering the profession through undergraduate routes are aged under 25; however, a third of postgraduate entrants are aged 25–29.

v. regardless of route, around 22% of male and female completers are not in service the year after they have completed their training.

Table 5.4 Proportions of science and mathematics PGCE entrants gaining QTS in England (2002–2003)

	PGCE course				
	Biology	Chemistry	Physics	Combined/ General	Mathematics
% gaining QTS	84.7	81.7	67.2	75.6	75.2
% still to complete	4.7	5.7	15.1	12.6	13.0
% withdrawn or withheld	10.7	12.6	17.7	11.7	11.8
Total	**966**	**366**	**305**	**783**	**1,557**

Sources: Adapted from Smithers & Robinson (2006). TDA Performance Profiles 2005, data for 2002–03.

Table 5.5 Employment of teacher trainees in science and mathematics in England (2002–2003)

Teaching destination:	PGCE course				
	Biology	Chemistry	Physics	Combined/ General	Mathematics
State school	82.8	78.0	78.4	75.8	80.2
Independent school	3.6	6.0	4.7	5.5	4.5
Still seeking post	1.5	3.5	2.1	3.2	1.7
Not seeking post	5.6	6.4	7.9	3.0	1.6
Not known	6.5	6.0	6.8	12.5	8.5
Total	**750**	**282**	**190**	**783**	**1,090**

Sources: Adapted from Smithers & Robinson (2006). TDA Performance Profiles 2005, data for 2002–03.

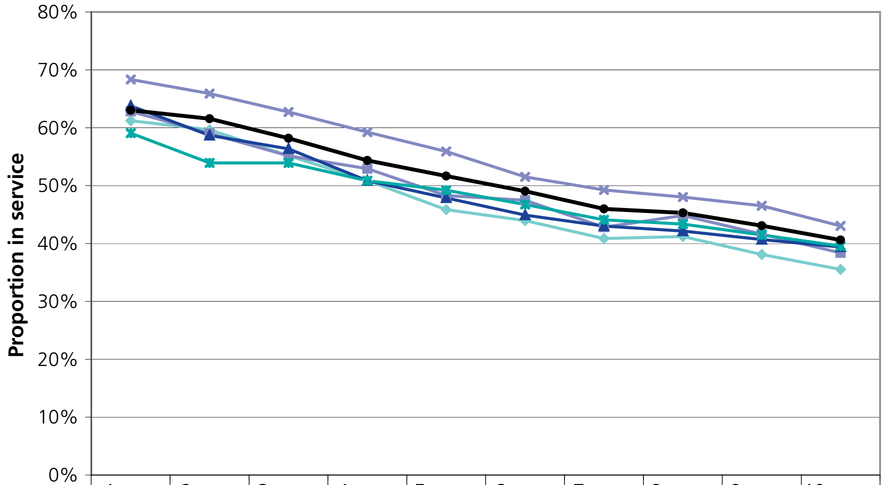
However, these data do not relate directly to science and mathematics teachers. In a recent report for the Gatsby Charitable Foundation, Education Data Surveys (EDS) Ltd obtained information from the DfES on completers of mathematics teacher training courses in 1995. This showed that of 1,552 completers, only 913 (or 58.8%) were in service one year later and 819 were still in teaching in 2001 (a further fall off of 10.3%). In 1999 there were only 950 mathematics completers, a little more than half the 1995 number, and of these 750 were in service one year later. While this initial drop-off among the 1999 cohort is considerably less than that recorded for the 1995 cohort of mathematics qualifiers, the number of completers in 1999 who were teaching a year post-qualification was only 200 fewer than that for the 1995 cohort. This difference of 200 between the cohorts was apparent in records of retention five years post-qualification.

EDS gained comparable data on science completers, which showed that of the 1,860 completers in 1999, only 1,300 (or 70%) were in service one year later and only 1,150 were in service after 5 years, representing a further drop off of 11.5%.

Few data appear to be available on retention among teachers of individual science subjects. However, Smithers & Robinson (2006) confirmed that not only is the intake of biology teacher trainees three times greater than that of physics trainee teachers, only two-thirds of physics trainees actually attain qualified teacher status (a crucial loss given the relatively small numbers involved). Only marginally more than two-thirds of physics trainee teacher entrants in 2002 had qualified by 2004, in contrast to at least three-quarters of other science teacher trainees and, of the remainder, 18% had either dropped out or had not been awarded the qualification, while a further 15% were still to complete (table 5.4).[63] Moreover, after completion, a greater proportion of physics completers were liable to choose not to teach (table 5.5).

63 Smithers, A & Robinson, P 2006 *Physics in schools and colleges*. Buckingham: CEER.

Figure 5.1 Proportion of those teachers who qualified in 1994 who were recorded in service in maintained secondary schools in England in subsequent years



	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years
Biology	0.61	0.60	0.55	0.51	0.46	0.44	0.41	0.41	0.38	0.36
Chemistry	0.63	0.59	0.55	0.53	0.48	0.47	0.43	0.45	0.42	0.38
Physics	0.64	0.59	0.56	0.51	0.48	0.45	0.43	0.42	0.41	0.39
Dual Science	0.68	0.66	0.62	0.59	0.56	0.52	0.49	0.48	0.47	0.43
Mathematics	0.59	0.54	0.54	0.51	0.49	0.47	0.44	0.43	0.41	0.40
all 1994 qualifiers (any subject)	0.63	0.62	0.58	0.54	0.52	0.49	0.46	0.45	0.43	0.41

Number of years after qualification

Source: DCSF.

This loss of newly qualified teachers raises a question concerning when precisely a new teacher may be counted as an addition to the workforce, and also what may be done to stem the loss and/or attract these individuals back into the workforce at a later date.

5.3 Retention of experienced teachers

Concerns about teacher retention have consistently been raised during the past 15 years. In 2000 and 2001 Smithers & Robinson (2000*a*, *b*, 2001) undertook two studies on behalf of the National Union of Teachers (NUT)[64]. The latter, referenced in a 2001 House of Commons debate on the Teaching Profession by David Rendel MP, revealed that 40 out of every 100 trainee teachers would not enter the classroom and a further 18 would leave teaching within 3 years of qualifying.[65] A host of other studies and reports have been conducted since, including by the House of Commons Education and Skills Committee (2004) and Smithers & Robinson (2003, 2004, 2005).[66] However, as Wilson & Demetriou (2006) observed, data are scarce and scattered.[67]

5.3.1 Retention of science and mathematics teachers in England

Data from the DCSF indicating the proportions of science and mathematics teacher qualifiers in 1994 and 1999 leaving the profession show that, while the rate of attrition among 1999 qualifiers was gentler than that among 1994 qualifiers (thereby indicating that retention may be increasing), as many as 30–40% of teachers were not teaching a year after they qualified (figures 5.1 and 5.2).

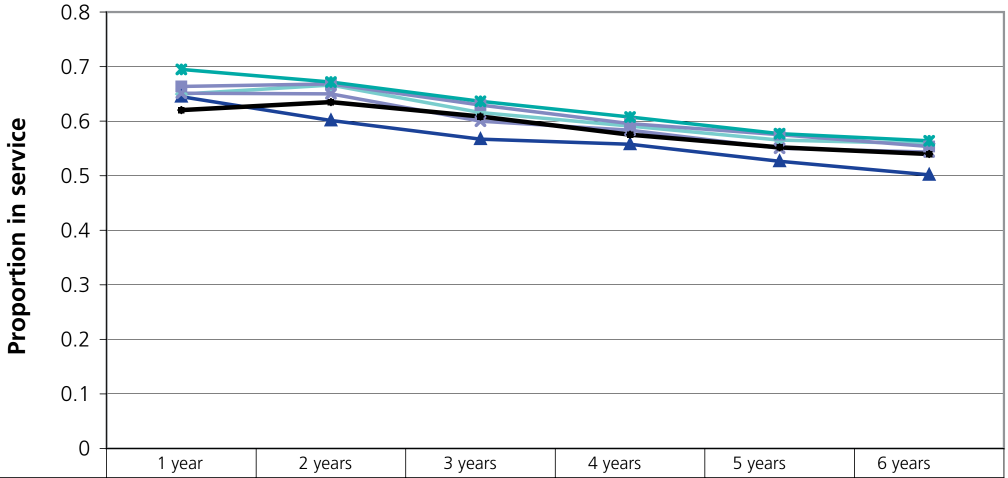
64 Smithers, A & Robinson, P 2000*a* *Coping with teacher shortages*. London: NUT. Smithers, A & Robinson, P 2000*b* *Attracting teachers. Past patterns, present policies, future prospects*. Liverpool: CEER. Smithers, A & Robinson, P 2001 *Teachers leaving*. London: NUT.

65 Hansard, 4 December 2001 (pt 1).

66 House of Commons Education and Skills Committee 2004 *Secondary education: teacher retention and recruitment. Fifth report of Session 2003–04. Volume 1*. London: The Stationery Office Ltd. Smithers, A & Robinson, P 2003 *Factors affecting teachers' decisions to leave the profession*. Liverpool: CEER. Smithers, A & Robinson, P 2004 *Teacher turnover, wastage and destinations*. Buckingham: CEER. Smithers, A & Robinson, P 2005 *Teacher turnover, wastage and movements between schools*. DfES research report 640. Buckingham: CEER.

67 Wilson, E & Demetriou, H 2006 Science teacher shortages: is there a 'leak in the education pipeline'? Paper presented at the British Educational Research Association Conference, September 2006, University of Warwick.

Figure 5.2 Proportion of teachers qualifying in 1999 recorded as in service in maintained secondary schools in England in subsequent years



	1 year	2 years	3 years	4 years	5 years	6 years
Biology	0.65	0.67	0.62	0.59	0.56	0.56
Chemistry	0.66	0.67	0.63	0.60	0.58	0.55
Physics	0.64	0.60	0.57	0.56	0.53	0.50
Dual Science	0.65	0.65	0.60	0.58	0.55	0.54
Mathematics	0.69	0.67	0.64	0.61	0.58	0.56
All subjects	0.62	0.63	0.61	0.58	0.55	0.54

Number of years after qualification

Source: Database of Teacher Records.

The subject indicates subject of qualification and not necessarily what the teacher is actually teaching.

This analysis adjusts for incomplete returns from local authorities.

Source: DCSF.

After just 5 years the attrition rate among 1994 qualifiers reached 50% and after 10 years, just 40% of the original cohort was still in service. It was consistently the case that attrition among those who qualified in science subjects was greater than that for all qualifiers, but the most serious initial drop-off occurred among teachers with mathematics, with 50% leaving the profession 4 years post-qualification (including those who never took up a teaching post within their first year post-qualification).

Supporting data come from the survey of former science PGCE students at the University of Cambridge by Wilson & Demetriou (2006).[68] They showed that of 188 respondents who had undertaken a PGCE at the University between 1997 and 2003 an average of 29% of each cohort had dropped out of teaching each year, which is considerably greater, in comparison, with the 9% attrition recorded among teachers across all secondary subjects.[69]

It is not clear what is responsible for the high attrition rates observed, particularly immediately post-qualification. It is likely that some female teachers will at some point leave teaching in order to raise a family, and that a number of these will return to the profession at a later date.

In comparison with other professions, it has been shown that loss from teaching has in the past considerably exceeded that from among GPs and the police force (figure 5.3), although data from more recent years, and across a wider range of professions, would be desirable.

5.3.2 Retention of science and mathematics teachers in Scotland

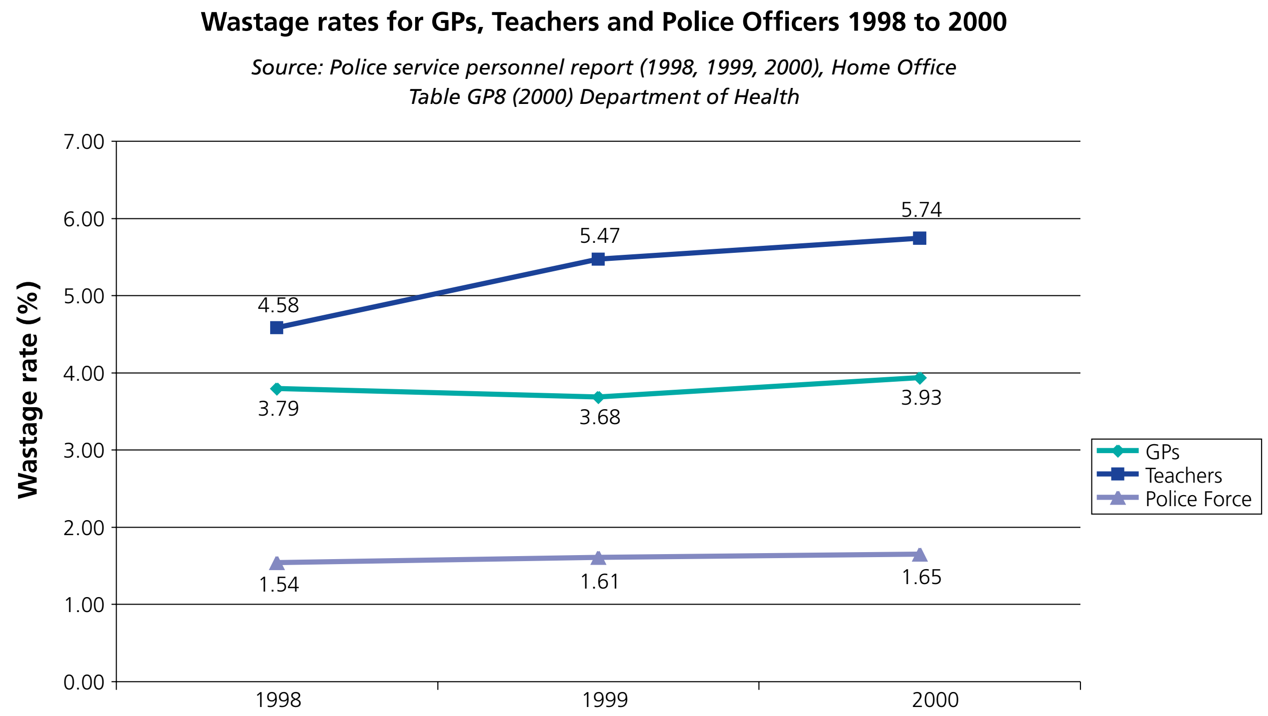
In Scotland, concerns were raised back in 2001 over recruitment to secondary schools (reported by the BBC on 15 March 2001) and on 6 December 2006 Aberdeenshire Council announced that it was seeking to attract teachers from the Republic of Ireland, New Zealand, Australia, Canada and South Africa to teach in its schools.[70] More specifically, the Royal Society of Chemistry highlighted shortages of chemistry teachers in Scotland; its survey of principal teachers

68 *Ibid*.

69 Rewards and Incentives Group 2006 *Joint evidence to the School Teachers' Review Body*. London: RIG.

70 BBC News 2001 Teacher shortages predicted (see http://news.bbc.co.uk/1/hi/scotland/1221419.stm). BBC News 2006 World studied for more teachers (see http://news.bbc.co.uk/1/hi/scotland/north_east/62113554.stm).

Figure 5.3 Comparison of attrition from teaching with attrition in other professions



Source: DCSF.

of chemistry from more than 400 schools revealing that 3 in every 10 local authority schools did not have enough chemistry teachers, that 81% had experienced problems finding chemistry supply staff and that 65% had used non-specialist supply staff to cover chemistry courses.[71] Similarly, data published in 2005 by the Scottish Mathematical Council found that 70% of the 249 respondents to its survey of mathematics education in Scotland reported experiencing teacher recruitment shortages in mathematics.[72]

5.3.3 Retention of science and mathematics teachers in Northern Ireland

In Northern Ireland, fewer concerns over teacher retention have been reported. The 2003 Curran Report asserted that 'there is no general shortage of teachers in Northern Ireland'.[73] But a recent study undertaken for the Department of Education Northern Ireland concluded that possible shortages of subject specialists were being masked by the use of non-specialist teachers at early secondary level. Nonetheless the same study affirmed that: 'Staff retention [does] not appear to present a major problem for most schools in Northern Ireland. Of the 83% employed in permanent full-time posts, 73% had between 6 and 29 years' teaching experience'.[74] Since career advancement (26%) and retirement (21%) were the most cited reasons for leaving among 887 leavers surveyed in this study, the suggestion here is that teachers in Northern Ireland are more likely to consider teaching as a lifelong career than their peers in the other home nations (Gray *et al*. (2006)). In addition, it was reported in 2006 that competition for places on initial teacher education courses in Northern Ireland remains intense and, unlike England, Northern Ireland has generally not experienced

71 Royal Society of Chemistry 2005 *Snuffing out the Bunsen burners. Scottish chemistry teacher survey.* Edinburgh: RSC Scottish Committee Education Division.

72 Scottish Mathematical Council 2005 *The future of mathematics teaching in Scotland.* (See http://www.maths.mcs.st-andrews.ac.uk/~smc/journal/SMCreportfinal.pdf)

73 Taylor, D & Usher, R 2004 *Aspects of initial teacher education in Northern Ireland*. Department for Employment and Learning.

74 Gray, C, Bell, I, Cummins, B, Eaton, P, Greenwood, J., McCullagh, J & Behan, S 2006 The recruitment and retention of teachers in post-primary schools in Northern Ireland. Research report no. 43, p. 63. Department of Education, Northern Ireland.

Table 5.6 Teacher returners (England) (1997/98–2004/05)

	1997/98	1998/99	1999/2000	2000/01	2001/02	2002/03	2003/04	2004/05
Re-entrants to full-time teaching in the maintained schools sector	5,300	5,410	5,870	7,070	8,710	7,820	6,870	8,080
Re-entrants to part-time teaching in the maintained schools sector	5,190	5,110	4,850	5,520	5,550	4,910	4,760	5,310

Source: Adapted from a table provided in House of Commons Hansard Written Answers for 29 January 2007 (see http://www.publications.parliament.uk/pa/cm200607/cmhansrd/cm070129/text/70129w0016.htm).

difficulties over teacher supply and recruitment.[75] The conclusions drawn here are similar to a report by the Campaign for Science & Engineering in the UK (CaSE) on science education in Northern Ireland, although the CaSE report picked up a feeling from post-primary teachers that 'there is an increasing awareness in the teaching community that there are shortages 'on the horizon''.[76]

5.3.4 Retention in the learning and skills sector

Research into teacher retention in the learning and skills sector appears to be limited. Most recently, in 2006 a team from York Consulting published a report on recruitment to and retention in the post-16 learning and skills sector. This gave some indications that science and mathematics teachers were less content than teachers of other subjects, but out of a total of 5,492 respondents, 84% of science teachers intended to be working as science teachers in a year's time, which compares with 81% of ICT and business administration teachers and 91% of technology teachers.

In July 2006, the report of the Advisory Committee on Mathematics Education on mathematics in FE colleges indicated that retention (as well as recruitment) was considered to be greatly influenced by pay, it being estimated that staff at GFE colleges earn on average £5,000 per year less than their compatriots in sixth form colleges.[77]

5.4 Turnover

Retention in post (as opposed to within the profession) is particularly poor in London, the East and South of England. Data from a survey of secondary schools in 2005 showed that the highest turnover of full-time permanent teachers was recorded among biology and mathematics teachers (see table A5.1).[78]

5.5 Returners

The TDA offers a 'Return to teaching' programme for people who are contemplating a return to teaching. In January 2007, the Schools' Minister provided data on entrants and leavers from the profession. Included among entrants were teachers returning to the profession and, as table 5.6 shows, the numbers of teacher returners in England have been increasing steadily overall, with full-time re-entrants increasing by 52% between 1997/98 and 2004/05. Encouraging as this undoubtedly is, the proportions of subject-specialists cannot be determined from such information.

Conclusions

i. Analysis of the Training and Development Agency for Schools' performance profiles reveals that drop-out rates among science and mathematics teacher trainees are, respectively, 16% and 18%, among the highest for subjects that the Government has

75 Schools for the future: funding, strategy, sharing. Review of the Independent Strategic Review of Education, December 2006, p. 73.

76 CaSE 2006 Science education in Northern Ireland's schools. Report of a series of *Opinion Forum* meetings with teachers, education, officials, educationalists, academics and other groups. CaSE 06/13b. London: Campaign for Science and Engineering in the UK.

77 Advisory Committee on Mathematics Education 2006 *Mathematics in Further Education colleges.* Policy Report ACME PR/08. London: ACME. (Available online at: www.acme-uk.org)

78 Local Government Analysis and Research 2006 Survey of teacher resignations and recruitment 1985/6-2005. Report no. 39. Main Report. (Available online at http://www.lgar.local.gov.uk/lgv/core/page.do?pageId=18679)

designated as priority for recruitment. Official figures for recruitment based on acceptances onto PGCE courses are therefore overestimates.

ii. Few data appear to be available on retention among teachers of individual science subjects, but evidence suggests that physics, the subject in greatest need of qualified teachers, suffers the most in terms of those not completing their teacher training or choosing not to teach after gaining qualified teacher status.

iii. Data from the DCSF show that as many as 30–40% of science and mathematics teachers qualifying in 1999 were not teaching a year after they qualified, and after 5 years the attrition rate reached as much as 50% among some subjects. Evidence collected by the Royal Society of Chemistry and the Scottish Mathematical Council indicates that the supply of qualified teachers in these subjects is not meeting demand in Scotland. In Northern Ireland, fewer concerns have been reported over teacher retention.

iv. Research into teacher retention in the learning and skills sector appears to be limited, but what is available suggests that despite relatively low levels of contentment, teachers of science and mathematics were more likely to stay in teaching than their counterparts in ICT and business administration.

v. The reasons behind teachers' deciding to leave the profession have been variously documented; retention in post appears particularly poor in London, the East and South of England.

vi. Data on retention of trainees, newly qualified and more experienced teachers of science and mathematics within the profession are very limited across the UK. Analysis of the reasons why teachers leave the profession at different stages of a career, taking into account age at qualification, is also lacking.

vii. There is a significant lack of data on teacher turnover and flow into and out of the profession, and the causes of this.

viii. Although, certainly for England, teacher returners seem to be on the increase, there appears to be no information about either their subject specialisms or the reasons for their return to the profession.

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 they 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.

6 Retirement of science and mathematics teachers across the UK

This chapter considers the loss of teachers from the active workforce through retirement. Of particular concern is the age structure of the workforce, with a significant proportion of science and mathematics teachers due to retire in the next few years.

6.1 Age profile of teachers across the UK

Tables 6.1–6.4 provide indications of the age of the science and mathematics teaching workforce across the UK. Unfortunately, only the Scottish sample may be considered inclusive of all subject specialist teachers, and the Northern Ireland sample is not only small, but also does not provide a convenient and comparable split of the data.

Nonetheless, the figures in tables 6.1–6.4 suggest that around a quarter (23.6%) of science teachers in England, just over one-quarter (26.2%) of science teachers (biology, chemistry, physics) in Wales, and over one-third (38.3%) of all science teachers (biology, chemistry, physics) in Scotland are aged 50 or more. While the data from Northern Ireland are not comparable, of the sample surveyed more than a third (36.8%) of science teachers proved to be at least 45 years old.

Similarly, almost a third (30.1%) of mathematics teachers in the England sample were found to be over 50, compared to a third (33.2%) of mathematics teachers in Scotland and almost a third (31%) of mathematics teachers in Wales. In the Northern Ireland sample, 37.8% of the mathematics teachers surveyed were at least 45 years old.

These data are in line with previous work by Smithers & Robinson (2005), which showed that nearly a third of physics-qualified physics teachers were aged over 50.[79]

It appears, then, that at least a third of science and mathematics teachers across the UK will shortly be up for retirement. Compared with other subjects, this is not an unusual situation. Indeed, Howson & Sprigade (2006) warned that an average of between 33% and 40% of teachers in secondary schools are likely to retire over the next 10 years.[80]

Table 6.1 Age profile of science teachers (and HoDs) in England

	Under 25	%	25–29	%	30–39	%	40–49	%	50–59	%	60+	%
Science (2,597)	143	5.5	509	19.6	707	27.2	624	24	580	22.3	34	1.3
HoD (science, 694)	0	0	31	4.5	222	32	223	32.1	213	30.7	5	0.7
Mathematics (3,036)	150	4.9	444	14.6	749	24.7	779	25.7	857	28.2	57	1.9
HoD (mathematics, 725)	1	0.1	26	3.6	221	30.5	240	33.1	232	32	5	0.7

Source: NFER report 2006, *op. cit.*, note 10.

79 Smithers, A & Robinson, P 2005 *Physics in schools and colleges. Teacher deployment and student outcomes*. Buckingham: CEER.

80 Howson, J & Sprigade, A 2006 From pupil to scientist – more or less? Findings and indications from the available data. In *Increasing uptake of science post-16. Report of a Royal Society conference held on Friday 10 March 2006 at the Royal Society, London*, p. 19. London: Royal Society.

Table 6.2 Age profile of science and mathematics teachers in Wales, 2007[a]

	No. aged under 25	No. aged 25–29	No. aged 30–39	No. aged 40–49	No. aged 50–59	No. aged 60 or over
Biology (510)	14	84	152	115	132	13
Chemistry (461)	14	75	154	108	98	12
Physics (426)	13	75	105	120	95	18
Science (1,253)	24	185	379	298	319	48
Mathematics (1,581)	34	209	436	412	432	58

Source: GTCW (April 2007).

a Number of teachers registered with the GTCW with one or more of these five subjects.

Table 6.3 Age profile of secondary school science and mathematics teachers by age in Scotland, 2006

	Under 25	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60 or over	average
All subjects (24,426)	1,127	2,747	2,377	2,261	2,605	3,820	5,143	3,842	504	44
Mathematics (2,653)	144	305	267	268	353	423	473	368	52	43
Biology (1,199)	55	176	122	87	101	185	244	168	18	43
Chemistry (1,021)	26	92	95	106	106	147	196	220	33	45
General Science (188)	*	23	16	20	28	40	37	24	*	44
Physics (936)	34	93	95	103	134	148	140	158	31	44

Source: Adapted from Scottish Executive 27 March 2007, table 3.10.

Table 6.4 Age profile of a sample of 278 science and mathematics teachers in Northern Ireland

	% aged 18–24	% aged 25–34	% aged 35–44	% aged 45–54	% aged 55–64
Mathematics (111)	5	30	23	35	7
Science (95)	5	30	30	28	7
Biology (23)	1	27	27	35	9
Chemistry (23)	1	25	33	30	11
Physics (26)	1	22	37	26	14

Age profile of 167 science and 111 mathematics teachers in NI (Gray *et al*. 2006).[a]

a *Op. cit*., note 73.

Conclusions

i. Data on the age profile of teachers show that across the UK, retirement levels among science and mathematics teachers are high, but similar to those among teachers of other subjects.

ii. The formulation of age profile data are inconsistent. No formal mechanism for keeping records of the age profile of science and mathematics teachers exists in Northern Ireland.

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.

7 Demand in the science and mathematics teaching workforce

This chapter investigates the demand for science and mathematics teachers within the active workforce, exploring extrinsic demands set by national policies and intrinsic demands as measured by two alternative indicators: vacancy rates and advertised posts.

7.1 Demand driven by national policies and strategies

The launch of the DfES/DTI/HMT/DoH *Science and Innovation Investment Framework 2004–2014* (July 2004), its subsequent development through the follow-up *Next Steps* document (March 2006), and the recent *STEM Programme Report* (October 2006) together mark the growth of a new shared desire between the science/education communities and English government to work together to reverse the negative trends in the uptake of STEM subjects post-16.

The *Next Steps* targets included ambitions to:

i. 'achieve year on year increases in the number of young people taking A levels in physics, chemistry and mathematics so that by 2014 entries to A level physics are 35,000 (currently 24,200); chemistry A level entries are 37,000 (currently 33,300); and mathematics A level entries are 56,000 (currently 46,168);

ii. continually improve the number of pupils getting at least level 6 at the end of Key Stage 3 (11-14 year olds);

iii. continually improve the number of pupils achieving A*-B and A*-C grades in two science GCSEs; and

iv. step up recruitment, retraining and retention of physics, chemistry and mathematics specialist teachers so that by 2014 25 per cent of science teachers have a physics specialism; 31 per cent of science teachers have a chemistry specialism; and the increase in the number of mathematics teachers enables 95 per cent of mathematics lessons in schools to be delivered by a mathematics specialist (compared with 88 per cent currently).'[81]

81 HM Treasury, DTI, DfES & DoH 2006 *Science and innovation investment framework 2004–2014: Next Steps*. London: HMSO.

These ambitions clearly suggest that a new demand for specialist teachers will be created, and for it to be fulfilled new specialist teachers in the sciences to be recruited and/or trained. However it is not clear how these numbers and proportions were calculated or how they flow from/feed into the Teacher Supply Model.

7.2 Demand among schools and colleges

Across the UK, data on teacher vacancies are published by the DCSF, Welsh Assembly and Scottish Executive. Currently the Department of Education Northern Ireland does not collect these data, despite a 2005 report on school statistics in Northern Ireland identifying 'the lack of statistics on teacher vacancies, including by subject' as a particular concern.[82]

The English, Scottish and Welsh authorities each have their own method of vacancy data collation and these are described in the following subsections. These differences mean that it is not possible to make consistent comparisons across the home nations.

7.2.1 Teacher vacancies in England

In England, vacancy information is published by the DCSF in its publication 'School workforce in England'. The DCSF's Form 618g is an annual survey of teachers in service and teacher vacancies normally conducted on the third Thursday in January. It includes advertised vacancies for full-time permanent appointments (and appointments of at least one term's duration) as well as temporary appointments of less than one term.

82 Allnutt, D 2005 National statistics quality review of schools statistics in Northern Ireland. Report, 19 March 2005.Bangorr, County Down: Department of Education, Northern Ireland (See http://www.deni.gov.uk/main_body_report.pdf)

Table 7.1 Full-time science vacancies in maintained secondary schools in England (2000–2007)

Subject	2000	2001	2002	2003	2004	2005	2006	2007(p)
Biology	15	26	28	6	13	24	13	17
Chemistry	9	42	41	35	28	23	24	23
Physics	25	50	46	43	26	32	26	25
Combined science	83	229	239	200	155	165	127	128
Other Science	24	51	29	29	11	9	18	16
Total all science subjects	**156**	**398**	**383**	**313**	**233**	**253**	**208**	**209**

Source: DfES, Form 618g; p, provisional.

The latest survey data, published on 26 April 2007, are presented in table A7.1, while table A7.2 considers revised vacancy figures across all subjects drawn from earlier 'School workforce' reports.

Table A7.2 shows that, as would be expected due to their statutory nature, English, science subjects and mathematics have consistently been responsible for the highest number of vacancies over the past eight years, notwithstanding the fact that data for England and Wales were combined until 2002. Table A7.1 shows vacancies as a percentage of teachers in post, showing an overall decrease in these subjects between 2001 and 2006, as noted by the Government in its evidence to the 2006 House of Lords inquiry into science teaching.[83]

Although they are not freely available, the DCSF does maintain disaggregated records of full-time science vacancies in maintained secondary schools, and these are reproduced in table 7.1 showing that data for the separate sciences follows the pattern of aggregated data outlined above.

Teacher vacancies indicate the mobility of the teaching profession, and have been suggested to be the most direct measure of teacher shortages.[84] However, the DCSF data are collected in January whereas data on vacancies collected from the *Times Educational Supplement* (TES) suggest proportionately more posts are advertised in March than in any other month.[85]

7.2.2 Advertised posts in England

An alternative measure to vacancy rates is the number of science and mathematics posts (all levels, and including permanent and temporary positions) advertised in maintained secondary schools during a calendar year in England and Wales, most of which are placed in the *TES*.

A continuous count of data from the *TES* for 2006 shows that during the course of the year in England more than 4,000 teaching posts in science were advertised and almost 4,000 teaching posts in mathematics (table 7.2). This compares with 3,407 posts advertised for English teachers, 782 for geography teachers, and 708 for history teachers.

Unfortunately it is not possible to say how many of these posts are re-advertisements, which would give a better indication of retention difficulties in schools. Nonetheless, these figures communicate a demand that is not reflected in the official statistics. The high numbers of general science posts advertised may well indicate that many schools are not bothering to advertise for such a rare commodity as a physics specialist since they know the chances of actually finding one are slim, and that instead they are making compromises or other contingencies in order to plug the hole. Notably, based on a survey of teachers, Smithers & Robinson (2000)[86] formalised a list of no less

83 Minutes of evidence taken before the Science and Technology Committee, Wednesday 28 June 2006. Memorandum from the Department for Education and Skills, the Department of Trade and Industry and the Training and Development Agency for Schools on science teaching in schools. In *Science teaching in schools. Report with evidence*, HL Paper 257, paragraph 21, p. 5. London: House of Lords.

84 White, P, See, B H, Gorard, S & Roberts, K 2003 *Review of teacher recruitment, supply and retention in Wales*. Working paper series no. 41, p. 26. Cardiff University School of Social Sciences.

85 Data collected from the *Times Educational Supplement* and Eteach.com by Education Data Surveys Ltd.

86 Smithers, A & Robinson, P 2000 *Coping with teacher shortages*, pp. iii–iv. Liverpool: Centre for Educational and Employment Research, Department of Education.

Table 7.2 Permanent science and mathematics teaching posts advertised in England (all Government Office Regions) in the *TES* and on Eteach.com (2006–2007)		
England	Year	
Post	2006	2007 (January–July)
Biology	261	168
Chemistry	301	271
Physics	346	335
Science – general	3,106	2,901
Science – other	21	1
Grand total	**4,035**	**3,676**
Mathematics	3,829	3,680
Grand Total	**3,829**	**3, 680**
Sources: Education Data Surveys Ltd, RS database.		

than nine tactics that headteachers may employ to cope with vacant positions. These include:

i. actively seeking out the staff who are available through networking, pre-emptive appointments, stealing a march on colleagues, using student placements to head hunt, appointing without seeing, and not being too specific in requirements;

ii. using part-time, temporary and supply appointments to paper over the cracks and also sometimes as an unofficial probationary period;

iii. relying on overseas staff particularly from Australia, New Zealand, South Africa and Canada;

iv. modifying the curriculum to fit the staff available;

v. raising class and group sizes;

vi. reducing non-contact time;

vii. increasing the amount of teaching staff that are asked to take lessons outside their subject, thereby reducing the match of skills to the job;

viii. on occasions using technicians and Ethnic Minority Achievement Grant (formerly Section 11) staff to teach;

ix. training up their own staff.

Further investigation of the data behind table A7.2 shows that there has been a greater need for departmental heads in science and mathematics than in other key areas of the curriculum (table A7.3), with the majority of posts being advertised in London and the South East. This demand seems to reflect both the acute shortages of science and mathematics specialists and, in addition, a certain level of professional dissatisfaction that has been recorded among science and mathematics departmental heads. Two recent reports have highlighted this problem of dissatisfaction: a study by Tikly & Smart (2006) found that 8 out of 14 mathematics departmental heads they surveyed were intent on finding an alternative role and the 2006 NFER report showed that 24% of 764 mathematics heads of department were broadly dissatisfied.[87] The NFER also found that 26% of science departmental heads were broadly dissatisfied with their work.

7.2.3 Teacher vacancies in Wales

The Welsh STATS3 return includes details of vacancies for full-time permanent appointments or full-time appointments of at least one term's duration recorded in January by the Welsh local authorities. Like the DCSF's Form 618g, the STATS3 return provides snapshot information on vacancies. Unlike the DCSF, the Welsh Assembly publishes the actual numbers of vacancies in preference to the percentage vacancy rate in January, which gives a more accurate picture of what is going on at that moment (table A7.4). But, significantly, it has also published more detailed data collected from schools on the numbers of posts advertised during the previous calendar year. Data in respect of secondary

87 Tikly, C & Smart, T 2006 *Career patterns of secondary mathematics teachers. Report of a project conducted on behalf of the Mathematical Association*, p. 16. Leicester: The Mathematical Association.

Table 7.3 Posts advertised (all types of teaching post, including permanent and temporary appointments) in maintained secondary schools across Wales (2006–2007)

Wales	Year	
Post	2006	2007 (January–July)
Biology	9	8
Chemistry	20	15
Physics	20	14
Science – general	53	34
Science – other	1	0
Total no. of science posts advertised	**103**	**71**
Mathematics	52	46
Total no. of posts advertised (all subjects in this table)	**155**	**117**

Sources: Education Data Surveys Ltd, RS database.

Table 7.4 Posts vacant for more than three months in science and mathematics subjects in secondary maintained schools in Scotland (2002–2007)

	2002	2003	2004	2005	2006	2007	Vacancies as % of per subject full teaching complement (2007)
Biology	1	1	5	6	3	–	–
Chemistry	2	–	6	12	3	3	0.3
Physics	6	3	7	11	1	3	0.3
General science	2	2	3	–	1	–	–
Mathematics	23	11	33	33	10	6	0.2
Total no. of vacancies across all subjects	**275**	**250**	**335**	**439**	**245**	**138**	

Source: Teacher vacancies and probationer allocations 2007, 26 June 2007 (Scottish Executive). Vacancy data not available for Aberdeenshire in 2002 or 2003.

science and mathematics teachers from the available surveys are reproduced in table A7.5 and show a similar situation to England, namely that with the exception of advertised posts in English, mathematics and science subjects (combined) contribute the majority of advertisements across all subjects in any particular year.

7.2.4 Advertised posts in Wales

Data collected by Education Data Surveys Ltd for 2006, presented in table 7.3, effectively provide a continuation of the record in the first three columns of data in table A7.5.

7.2.5 Teacher vacancies in Scotland

The Scottish Executive conducts an annual survey of teacher and educational psychologist vacancies each February. Like the Welsh STATS3 return, this includes advertised vacancies for full-time permanent appointments (or appointments of a least one term's duration). Table A7.6 provides limited information on vacancies recorded in science and mathematics subjects over the past 5 years.

In addition, the Executive collects and publishes information on posts that have been vacant for more than three months, which gives an indication of schools struggling to recruit staff to vacant positions (table 7.4).

Table 7.5 Number of permanent science and mathematics teaching positions advertised in secondary maintained schools throughout England by Government Office Region in 2006 in the *TES* and on Eteach.com

Subject	London	East Midlands	East of England	North East	North West	South East	South West	West Midlands	Yorkshire and the Humber
Biology	41	22	36	11	24	41	30	32	24
Chemistry	54	21	34	12	42	48	29	43	18
Physics	54	27	41	18	39	66	32	40	29
Science – general	517	284	415	93	305	652	237	343	264
Science – other	3	3	2	–	2	5	1	1	4
Total no. of science posts	**669**	**357**	**528**	**134**	**412**	**812**	**329**	**459**	**339**
Mathematics	523	344	517	145	448	770	299	433	350
Total no. of science and mathematics posts advertised	**1,192**	**701**	**1,045**	**279**	**860**	**1,582**	**628**	**892**	**689**
Population (thousands)[a]	7,591.3	4,335.2	5,567.6	2,553.5	6,871.1	8,205.1	5,112.8	5,373.3	5,038.8
Number of specialist schools[b]	335	227	299	144	399	404	285	337	262

Sources: Education Data Surveys Ltd, RS database.

a Office for National Statistics 2004-based Subnational population projections for 2006 (see http://www.statistics.gov.uk/downloads/theme_population/2004_BasedProj/01_GovtOfficeRegions.xls).

b Data on specialist schools from the DCSF.

7.2.6 Regional issues

With reference to England, Wales and Scotland, there appears to be no indication of the existence of particular factors that may serve to impact the ease with which vacancies are filled, for instance whether the majority of positions vacant are urban or rural. However, data for the Government Office Region (GOR) of London (table 7.5) show that, when compared with the data in table 7.2, in 2006, 13.9% of all mathematics posts advertised in England and 17% of all science posts advertised in England were in London maintained secondary schools.

Looking more widely across the GORs it is evident that the numbers of posts advertised vary greatly from region to region. This variation relates to the demographics of these regions and the number of secondary schools they contain, but the number of general science posts on offer consistently outnumbers those in any other science. This may be due to schools' inability to recruit subject specialist teachers and/or the greater availability of science teachers with a PGCE in combined science.

It is not possible to acertain whether 11–16 schools have greater difficulties in recruiting science and mathematics teachers than 11–18 schools, nor is it possible to tell from these data the impact of demography or whether the geographical situations of schools affects the ease with which they can recruit and retain new staff.

7.2.7 Sectoral issues

There seems to be little information concerning transfer from one educational sector to another. Smithers & Tracey (2003) found that 28.5% of teachers appointed to independent schools had come from maintained schools, whereas only 10% moved in the opposite direction.[88]

88 Smithers, A & Tracey, L 2003 *Teacher qualifications. Report for the Sutton Trust, January 2003*. Centre for Education and Employment Research, University of Buckingham.

Conclusions

i. Establishing a true picture of demand, and whether that demand has been met, is very difficult, partly because schools may be advertising for what they feel they can get, particularly in deprived inner city areas or geographically isolated localities, rather than what they actually want. Further, some schools may have to advertise the same post more than once.

ii. A continuous count of advertisements from the *Times Educational Supplement* and Eteach.com shows that more teaching posts in science and mathematics were advertised in England during 2006 than was the case in English, geography and history. Unfortunately, we cannot be certain how many of these posts are re-advertisements, which would give a clearer indication of retention difficulties in schools.

iii. Data for the Government Office Region of London (table 7.5) show that significant proportions of science and mathematics posts advertised in 2006 were in maintained secondary schools. Further investigation shows that there has been a greater need for departmental heads in these subjects than in other key areas of the curriculum (table A7.3), with the greater numbers of posts being advertised in London and the South East than anywhere else.

iv. Data concerning secondary science and mathematics teachers in Wales show a similar situation to England, namely that with the exception of advertised posts in English, science and mathematics (combined) contribute the majority of advertisements across all subjects in any particular year.

v. It is not possible to ascertain whether 11–16 schools have greater difficulties in recruiting and retaining science and mathematics teachers than 11–18 schools, nor is it possible to tell from these data whether demography and geography of schools affects the ease with which they can recruit and retain new staff.

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.

8 Factors affecting the recruitment and retention of science and mathematics teachers

The previous chapters on (i) supply and demand for science and mathematics teachers and (ii) retention of these teachers showed that headline data alone are unable to explain the reasons behind whatever trends are observed. This chapter explores key factors that affect the recruitment and retention of teachers. Wherever possible it looks at these factors in relation to science and mathematics, but there is a dearth of such subject-specific data available. Finally, we take a look at strategies that may help boost retention.

8.1 Pay and labour market conditions

Teachers' starting pay varies according to the associated costs of where they are working. From September 2006, classroom teacher salaries throughout England and Wales began at £19,641, but reflecting higher costs of working and living in and around London, this basic rose to £20,586 for those on the 'fringe' of London, to £22,554 for those in Outer London, and to £23,577 for those in Inner London.

These figures contrast markedly with the median starting salary in 2006 recorded by the Association of Graduate Recruiters (AGR) in its summer 2006 survey of graduate recruiters, of £22,953 (or up to £27,500 in London), and indicate that consistently across the regions, teachers fare worse than other graduates, without taking into account the costs associated with 4 years of higher education. The AGR survey is particularly representative of leading companies (including banks and law firms). An alternative annual survey of 2,000 final year students conducted by *The Guardian* in 2006, published as 'GradFacts', indicated that the average salary expectations of males were £19,642 and of females were £18,188, but that the average salary expectation for someone entering 'education' was just £18,187.[89] This figure of £18,187 is 8% below graduate males' average salaries, which may help to explain why fewer male than female graduates apply to PGCE courses, and is substantially below the average expected graduate starting salary for 2006 (of £20,300) announced by the *UK Graduate Careers Survey 2006*, which was based on a survey of 16,452 final-year students in UK universities.[90]

89 See http://www.adinfo-guardian.co.uk/recruitment/microsites/gradfacts/gradfacts-skills-salary.shtml

90 High Fliers Research Limited 2006 *The UK Graduate Careers Survey 2006. Survey Summary*, pp. 5, 16. London: High Fliers Research Limited.

Science and mathematics teachers who started teaching in a maintained school in September 2006 would have become eligible for their 'golden hello' at the start of September 2007, worth £5,000 (taxable). When added to their second year salary (based on the main scale teacher salaries set for 1 September 2007), a science or mathematics teacher working in the regions outside London would earn £26,726, and £30,548 if working in Inner London. However, come 1 September 2008, their pay would once again be on the main scale, meaning that earnings for newly recruited science/mathematics teachers outside London and in Inner London would slide back down to £23,472 and £27,327, respectively.

Given the results of the AGR survey, it is scarcely surprising, as Chevalier & Dolton (2004) asserted, that this differential between teachers' starting salaries and those of employees in other professions is a significant determinant of graduate occupation.[91] And it is not surprising then that interest in teaching tends to wax when the economy is suffering, whereupon graduates seek a 'safer bet', and wanes when the economy is bullish.

8.2 Regional and geographical differences

8.2.1 Pay

The 2006 AGR survey found that the median graduate starting salary in London of £27,500 was the highest of all UK regions and significantly above that of the next highest paying region, the South East (£22,000). Teacher salaries vary across the regions, too, and particularly across the South East and London regions, where both competition for graduates and housing

91 Chevalier, A & Dolton, P 2004 *The labour market for teachers*. Paper WP04/11, May 2004. Dublin: Centre for Economic Research, University College Dublin.

Table 8.1 Graduate-teacher salary ratios by subject and Government Office Region[a]

Government Office Region	Graduates	Biology	Chemistry	Physics	Mathematics (and related)
North East	0.95	0.88	0.97	0.93	0.93
North West	0.97	1.00	1.1	1.06	1.09
Yorkshire	0.97	0.72	1.06	1.16	1.05
East Midlands	0.88	0.74	0.99	0.96	1.13
West Midlands	0.93	0.62	0.96	0.91	1.02
Eastern	1.05	1.07	1.19	1.22	1.28
London	1.13	0.92	1.16	1.18	1.23
South East	1.16	0.95	1.19	1.19	1.2
South West	0.93	0.82	0.92	0.96	0.97

Source: NFER (2006).

a Values greater than 1 indicate that the average salary of holders of that type of degree is greater than that of teachers in that particular Government Office Region.

prices are greatest. Professor Bob Moon of The Open University told the House of Lords Science and Technology Select Committee during its inquiry into 'Science teaching in schools' that Hillingdon 'could not get a head of maths and they could not get any maths teachers', while Graham Lane of the National Employers' Organisation for School Teachers (NEOST) reported particular problems in recruiting in Essex owing to the fact that housing is cheaper there and teachers need only make a short train ride in order to benefit from better-paid positions in London.

Further, a comparison of average graduate salaries against the salaries of teachers (table 8.1) showed that while salaries vary from region to region across England, the salaries of graduates, and of specialist science and mathematics graduates, tend to be higher than those of teachers. This is generally the case across the highly competitive employment areas of London, the South East and Eastern regions.

8.2.2 Housing costs

Housing costs are recognised as being a significant determinant of recruitment and retention of teachers. In its submission to the School Teachers' Review Body in May 2007, the National Union of Teachers (NUT) drew heavily on the Halifax's Key Worker Housing Review. Across England and Wales, the Review found that the North was the only region in which house prices were affordable for teachers, and that in the highly competitive areas of Greater London, the South East, as well as in the South West and East Anglia, '99 or 100%' of towns' house prices were beyond teachers' affordability. The submission suggests that teachers may incur significant additional travel costs on account of their not being able to live close to the schools they teach in, and that time spent commuting to and from school will reduce their energy and commitment, and upset their work/life balance.[92]

It stands to reason that these sorts of stresses are exacerbated for schools in challenging areas, which as the DfES acknowledged to the House of Commons Education and Skills Select Committee tend to suffer from many of the sorts of attributes that are liable to put teachers off teaching in them: 'Schools which have high proportions of pupils who enter with low attainment or with behaviour problems; schools which have poor and decaying buildings and fabric; and schools whose leadership and management standards are poor are likelier to have difficulties with both standards and retention' (DfES 2004).[93]

92 National Union of Teachers 2007 *Submission to the School Teachers' Review Body*, May 2007. London: NUT.

93 House of Commons Education and Skills Committee 2004 *Teacher retention and recruitment. Fifth report of Session 2003–04. Volume II. Oral and written evidence, Ev 161*. London: The Stationery Office Ltd.

Table 8.2 Pay, weekly hours and holidays of teachers in the state and independent sectors (1996–2000 and 2001–2005)

	1996–2000		2001–2005	
	State	Independent	State	Independent
Male				
Holidays (days/year)	57.4	67.3	59.2	65.8
Unpaid overtime (hours/week)	10.2	5.7	10.2	8.3
Total usual hours/week	45.3	48.2	45.9	50.7
Real gross hourly wage (£)[a]	13.0	13.1	13.9	14.2
Real gross weekly pay (£)[b]	573.9	610.0	634.7	704.1
Female				
Holidays (days/year)	56.6	63.1	57.3	58.6
Unpaid overtime (hours/week)	10.2	6.4	10.3	6.8
Total usual hours/week	41.5	38.2	41.6	40.1
Real gross hourly wage (£)[a]	11.8	11.3	12.7	12.5
Real gross weekly pay (£)[b]	469.0	421.0	517.0	503.0

Source: Quarterly Labour Force Survey, adapted from Green *et al*. (2007).
a, b January 2006 prices.

8.3 Reasons for science and mathematics teachers leaving the profession

The period of service that a teacher gives will be dependent on a number of factors:

i. the age at which they complete their training and embark on a teaching career;

ii. their experiences of teaching;

iii. their success as teachers (measurable against objective measures in respect of student performance, continuing professional development, promotion and more qualitative indicators);

iv. their health; and

v. the need for a career break, particularly for family reasons.

The reasons why teachers leave the profession have been variously documented, and particularly investigated by Smithers & Robinson (2001, 2003, 2004) who found in their 2003 study that out of a total of 1,051 teachers who responded to a questionnaire (across primary, middle, secondary and special schools), almost half (44.8%) indicated that too heavy a workload was the major factor in their decision to leave, while approximately a third blamed Government initiatives and stress (36.4% and 34.5%, respectively). A more recent study of science teacher retention, conducted by Sheffield Hallam for the Royal Society, showed that science teachers in the maintained sector leave the profession for the following reasons:

i. frustration over lack of professional autonomy and ability to be creative in work;

ii. quality of working life (lack of leadership and management opportunities, involvement and control of their work);

iii. the paucity of coherent policies and strategies in place for retention and programmes in place to extend their professional knowledge and skills;

iv. high teaching and bureaucratic workload;

v. poor pay;

vi. low status and morale arising from poor leadership and management and contributing to feeling of being undervalued;

vii. lack of influence on school policy;

viii. poor student discipline and motivation;

ix. inadequate facilities and resources.[94]

A study on recruitment and retention in the learning and skills sector that had a particular focus on science and mathematics found that teachers of these subjects offer similar reasons for dissatisfaction/leaving the profession, notably the amount and quality of resources available to them, workload, low status and morale, and poor pay in comparison with their counterparts in the school sector.[95]

8.4 Differences between the maintained and independent sectors

The extent to which the reasons given in § 8.3 would be shared by science and mathematics teachers in the independent sector is unclear, but a recent study has acknowledged that teachers in independent schools are recognised as benefiting relative to their counterparts in maintained schools from having smaller classes, better facilities, and students who are generally less likely to be disruptive and are more committed to learning (Green *et al*. 2007).[96]

In comparing Quarterly Labour Force Survey (QLFS) figures for 1996–2000 with equivalent figures for the years 2001–2005, a notable convergence in working conditions across these sectors is observable (table 8.2). Nonetheless, during 2001–2005, teachers in independent schools enjoyed more annual holiday than teachers in maintained schools, and male teachers in both the state and independent sectors had more holiday than their female counterparts. However, the QLFS figures record that while male teachers in independent schools also earned more than male teachers in the state sector, the opposite was true for female teachers.

94 Harrison, W, Windale, M & Thompson, M 2005 *The retention of science teachers. Scoping study to identify and define the various retention problems which exist in secondary science departments and identify potential departmental strategies to address these problems*. Sheffield: Centre for Science Education, Sheffield Hallam University.

95 Wilson, P, Hopwood, V & Antill, M 2005 *Recruitment and retention in the post-16 learning and skills sector*. DfES Research Report no. 697. Nottingham: DfES.

96 Green, F, Machin, S, Murphy, R & Zhu, Y 2007 'The labour market for private school teachers'. Paper, presented at the European Association of Labour Economists (EALE) 2007 conference in Oslo, Norway, in September 2007.

8.5 Strategies that may enhance teacher retention

8.5.1 National initiatives

In recent years, a number of initiatives have been established that are geared, at least in part, towards encouraging teacher retention, many of which are concerned with continuing professional development. These include the establishment of the following:

i. the Science Learning Centres (SLCs) from October 2004, which provide continuing professional development opportunities for science teachers and technicians;

ii. the National Centre for Excellence in the Teaching of Mathematics (NCETM) in June 2006, which is working to drive up the skills, effectiveness and aspirations of mathematics teachers;

iii. the Independent/State School Partnership Programme (ISSP) set up by the DfES in 1998, which Ofsted reported as being valuable in developing effective cross-sector collaboration and which, through its CPD strand, has an express aim to help increase GCSE and post-16 uptake of science and mathematics in maintained schools;[97,98]

iv. the collaborative network of support between specialist schools fostered by the Specialist Schools and Academies Trust;

v. Chartered Science Teacher status, by the Association for Science Education in 2006, in order to promote high quality science teaching and learning; recognise high and improving professional expertise; and reflect best effective practice in science education; and

vi. the Physics Enhancement Course set up by the Institute of Physics and the TDA in January 2004, which provides specialist subject knowledge training for people wishing to teach physics as preparation for a physics PGCE course, support for the subsequent PGCE course they undertake and a mentoring scheme for the first 2 years post-qualification.

97 Ofsted 2005 Independent/state school partnerships. HMI 2305. (Available at http://www.ofsted.gov.uk/asset/3877.doc)

98 Independent state school partnerships forum. Report to ministers, January 2006. (Available at http://teachernet.gov.uk/docbank/index.cfm?id=9908)

The success of the majority of these creative strategies depends on secured long-term funding and, a shared understanding between Government and the science and mathematics education communities concerning what must be done to ensure that the goals of science and mathematics education outlined in chapter 1 are achieved. In addition, further policy-making and greater flexibility at school level will be required to ensure that teachers are able to benefit from the opportunities that are ostensibly being presented to them.

Accordingly, it is notable that the recent Sainsbury Review recommended that the Science Learning Centre network should be funded in the long-term by the DCSF.[99] In addition, the Review recognised that financial incentives need to be provided in order to encourage teachers to take advantage of the CPD opportunities available, that teachers' and head teachers' attitudes towards CPD may need to change, but that these attitudes are affected by practical constraints such as inability to pay for supply teacher cover or an insufficiency of supply teachers.

8.5.2 Pay and management matters

As § 8.3 showed, low pay and poor leadership are important reasons behind science teachers' decision to leave the profession. Critically, the STRB in its 2007 report concluded (i) that teachers should receive a financial incentive for completion of accredited qualifications in priority subjects designated by the DCSF or Welsh Assembly; and (ii) that head teachers should use the flexibility they have over salary awards to address local teacher shortages in science and mathematics, with this being made possible through effective support for local managers, a sharper framework of accountability and effective school budgets.[100]

Conclusions

i. The ease, or otherwise, with which both trainees and new teachers may be recruited – and indeed retained – by schools and colleges is related to a range of factors, including pay and the costs of living, including housing and commuting, and non-monetary concerns (eg workload).

ii. A range of strategies has been launched to enhance teacher retention. The benefits of these schemes will only be reaped over time and, for many, success is dependent upon long-term investment.

99 Lord Sainsbury of Turville 2007 The race to the top. A review of Government's science and innovation policies.London: HM Treasury.

100 School Teachers' Review Body 2007 *Sixteenth Report*, Cm 7007, pp. 3–17. London: The Stationery Office.

9 Workforce planning for science and mathematics teachers

This chapter examines the relationship between Government targets and actual recruitment into teaching. It considers teacher workforce modelling and forward-planning, examining existing and alternative models, taking account of elements discussed in the previous chapters in the context of current imperatives with respect to science and mathematics teacher supply.

9.1 Modelling changes in the teaching workforce across the UK

Modelling the future growth of the workforce is a complicated undertaking. As has been observed, 'predicting the exact numbers of teachers required and, for post-primary education, apportioning precisely an estimate of the number of teachers required in each subject area, are notoriously difficult to achieve' (Taylor & Usher 2004).[101] Little information on modelling teacher numbers is freely available. The focus here is on the DCSF's model, which has informed target setting in Wales, but it is important to recognise that both Scotland and Northern Ireland have their own analogues, respectively the Teacher Workforce Planning Model and the Teacher Demand Model.

The DCSF's projections are actually based on three models: the Teacher Supply Model (TSM), which models the flow of teachers into and out of the maintained sector (including nursery/primary and secondary schools); the ITT intake model, which estimates the required ITT intake, separately for both nursery/primary and secondary maintained schools, ie the number of completers that the TSM estimates are needed to maintain supply; and the Secondary Teacher Supply Model, which breaks down the figures for movement of secondary teachers calculated from the TSM by main subject of highest qualification. 'Smoothing' procedures are applied to control for unexpected changes in numbers over the years.

The Teacher Supply Model (TSM) was first published by the Department of Education and Science in 1990, and updated by the Department for Education and Employment in 1998, when workforce planning for Wales was still under the Department's control.[102] Despite devolution, it is still used to project future numbers of teachers and to set ITT recruitment targets in Wales. The mechanism by which these 'corrected' data for Wales are generated is described below.

'Once the Model has calculated the number of ITT places needed across Wales and England as a whole, it calculates a standard percentage (currently 8.7% of the total), which is assigned to Wales. These targets are advisory only for Wales and officers within the Welsh Assembly Government then review them before setting actual numbers. At this point, the Welsh Assembly Government add in Wales-only requirements such as the demand for Welsh medium teachers. It is important to note that although advice on the numbers needed is provided by the DfES, this is indeed only advice and the funding for places is the responsibility of the Welsh Assembly Government' (Furlong *et al*. 2006).[103]

9.2 Targets for traditional recruitment into science and mathematics ITT via the PGCE

Although a technical description of its model was first published in 1990, the Department has actually been setting recruitment targets for teacher training places since 1983.[104] Naturally, a critical measure of the Government's performance is whether actual recruitment to ITT (across all undergraduate and postgraduate routes) in science and mathematics is in line with the targets that it has set. It is notable,

101 Taylor, D & Usher, R 2004 Aspects of initial teacher education in Northern Ireland. A report by David Taylor and Rod Usher, Independent Consultants to the Department for Employment and Learning (DEL), p. 11.

102 Department for Education and Employment 1998 *Teacher supply and demand modelling. A technical description*. London: The Stationery Office.

103 *Op. cit.*, note 45, paragraphs 3.7–3.8, p. 41.

104 Smithers, A & Robinson, P 2000 *Attracting teachers. Past patterns, present policies, future prospects*. Liverpool: CEER.

Table 9.1 Comparison of recruitment into science and mathematics ITT courses (England) (2000/01–2006/07)[a]

Secondary Subjects	2000/01		2001/02		2002/03		2003/04		2004/05		2005/06		2006/07[b]	
UG/PG	Target	Recruit	Target	Recruit	Target	Recruit	Target	Recruit	Target	Recruit	Target	Recruit	Target	Recruit
All subjects	16,615	14,540	17,390	16,060	17,790	16,760	19,475	18,290	19,500	17,980	18,500	17,440	17,500	17,040
Science	2,690	2,410	2,810	2,590	2,850	2,700	3,225	2,870	3,225	2,830	3,225	2,890	3,225	2,990
Mathematics	1,850	1,290	1,940	1,550	1,940	1,670	2,315	1,940	2,350	2,030	2,350	1,920	2,350	2,000
Biology														*930*
Chemistry														*530*
Physics														*350*
General Sciences														*1,180*

Sources: DfES, RS database. Note: undergraduate (UG) and postgraduate (PG) recruitment data are combined.

a Figures included here cover universities, other higher education institutions, SCITT centres and the Open University, but exclude employment-based routes. Fast Track is included from 2001/02.

b Provisional data.

Table 9.2 Percentage recruitment (ITT) in respect of targets (England) (2000/01–2006/07)

	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07
Science	89.6%	92.2%	94.7%	89.0%	87.8%	89.6%	92.7%
Mathematics	69.7%	79.9%	86.1%	83.8%	86.4%	81.7%	85.1%

Sources: DfES, RS database.

however, that the Government only sets targets for conventional recruitment into ITT through the PGCE; it does not set any targets for recruitment from employment-based routes into teaching.

Table 9.1 compares recruitment targets with the numbers actually recruited into teacher training during the past 7 years. While the data show an overall rise in numbers recruited to ITT courses in science and mathematics in England, there is a consistent failure to meet recruitment targets in science and mathematics, shown in more detail in table 9.2. For mathematics, recruitment targets have generally been missed by 15% or more each year since 2000/01.

For the academic year, 2006/07 data concerning recruitment into science ITT have been disaggregated according to science subject. Table 9.1 shows a significant bias towards recruitment into biology and combined science ITT, with only 12% opting to specialise in physics teaching at this stage and 18% opting for chemistry. Without any data from previous years to refer to, it is impossible to say whether recruitment into the separate sciences in ITT has reflected graduate output, but these data make clear the fact that these targets are not demand-led (ie according to the balance of specialisms within science), but supply-led (as is clear from the disproportionate numbers of biology graduates applying and being accepted for teacher training).

Finally, while the targets are also consistently undershot, taking into account figures for non-completion of ITT (see chapter 5, § 5.1), undershoot in terms of actual recruitment into the workforce increases. Although the Government's Teacher Supply Model (TSM) accounts for 'wastage' from among the population of undergraduate and postgraduate ITT students, the difference apparent between initial and actual recruitment onto initial teacher training courses appears to be rather more than that allowed for in the TSM. Indeed, the 1998 TSM indicates that an overall allowance of only 11%

is made for postgraduate 'wastage'.[105] Further, given as shown in chapter 5, drop-out post-acceptance onto an initial teacher training course, during such a course and immediately post-qualification, it is essential that 'recruitment' into teacher training is not confused with recruitment into the profession.

9.3 The *Next Steps* targets and their relation to the Teacher Supply Model

The *Next Steps* targets include a commitment by the Government to:

'step up recruitment, retraining and retention of physics, chemistry and mathematics specialist teachers so that by 2014, 25 per cent of science teachers have a physics specialism (compared to 19 per cent currently); 31 per cent of science teachers have a chemistry specialism (compared to 25 per cent currently); and the increase in the number of mathematics teachers enables 95 per cent of mathematics lessons in schools to be delivered by a mathematics specialist (compared with an estimated 88 per cent currently)' (paragraph 6.13, *Next Steps*).[106]

From paragraph 6.18 of the *Next Steps* document, it appears that these targets derive from the proportions of science teachers in maintained schools in England estimated in the NFER (2006) report.[107] However, the Government has never made clear what the basis of these targets is.

Nonetheless it has produced projections to show how the target for physics and chemistry teachers will be met (tables 9.3 and 9.4). These projections derive from estimates taken from the SSCSS 2002/03 scaled to data from the Database of Teacher Records (DTR), but the assumptions underlying them are not at all clear.

Unfortunately, as was observed in chapter 3, the 2002/03 SSCSS is decidedly unreliable on account of its extremely small sample size (see table A3.1), which precluded any count of the number of subject specialists. Consequently, the origins of the figures for 'stock', that is the number of full-time specialist teachers in maintained schools, are unclear. Further, although these projections show the cumulative impact of estimated inflow and outflow from the workforce, it is not clear how they have been derived, though presumably they have been calculated from the TSM.

Worryingly, given the recruitment to physics and chemistry initial teacher training recorded for 2006/07 (table 9.1), it is hard to imagine how such large increases in inflow as prescribed by the projections in tables 9.3 and 9.4 are possible. Moreover, although thousands of teacher returners are recorded, the number of subject specialists is not known (see chapter 5, § 5.6). Notably, evidence from the Rewards and Incentives Group submitted to the School Teachers' Review Body in 2006 suggested that increasing the proportion of science teachers with a physics specialism would require approximately 700 new physics teachers to be recruited each year for the next 10 years. The Group estimated that if all these new recruits were physics graduates, then 'about 1,000 new recruits to ITT would be needed (due to the drop out rate during courses and between completing ITT and teaching) that is equivalent to recruiting over 50% of the total physics graduate population'.[108] Given that the 'Prospects' website recorded a total of 1,950 physics graduates in 2004,[109] and, one might add, that the number of physics acceptances in England has not exceeded 520 in the past 6 years (table 4.4), it is unsurprising the Group concluded that such a feat is 'improbable'.[110]

Finally, it is unclear whether, or to what extent, these projections take account of the increased need for specialist science teachers that comes from another of the *Next Steps* commitments, namely the entitlement for all young people who gain Level 6 or above in their Key Stage 3 tests to study the separate sciences at GCSE.

9.4 The Teacher Supply Model in use in England for mathematics teachers

While *Next Steps* sets precise targets for the percentages of physics and chemistry specialist teachers required by 2014, it merely indicates that the number of mathematics teachers needs to increase so as to ensure that 95% of mathematics lessons are taught by mathematics teachers as opposed to the 88% level being delivered back in 2006.

105 DfEE 1998 *Teacher supply and demand modelling. A technical description*, p. 43. London: The Stationery Office.

106 *Op. cit.*, note 81.

107 *Op. cit.*, note 10.

108 Rewards and Incentives Group 2006 Evidence from the Rewards and Incentives Group to the School Teachers' Review Body, 21 July 2006, paragraph 5.30.

109 Data for 2004 and 2005 graduates are available at http://www.prospects.ac.uk/cms/ShowPage/Home_page/What_do_graduates_do__2007/p!eaLidbl.

110 *Op. cit.*, note 68.

Table 9.3 Projection for number of physics teachers based on modelling carried out in March 2006[a]

	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Stock	6,600	6,600	6,600	6,700	6,700	6,900	7,100	7,200	7,400	7,500	7,600
Outflow[b]	600	700	700	700	700	700	700	700	700	700	700
Inflow – ITT entrants[c]	300	300	400	400	500	500	500	500	400	400	400
Inflow – other entrants[d]	400	300	300	400	400	400	400	400	400	400	500
Total inflow	700	700	700	800	900	900	900	900	800	800	900
Net balance	+100	0	0	+100	+200	+200	+200	+200	+100	+100	+200

Source: DfES (adapted).

a Figures have been rounded to nearest 100.

b Retirements and teachers moving out of the maintained sector.

c Includes entrants through employment based routes.

d Teachers returning to the maintained sector, or new to the maintained sector (ie not newly qualified).

Table 9.4 Projection for number of chemistry teachers based on modelling carried out in March 2006[a]

	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Stock	8,500	8,600	8,600	8,700	8,800	8,900	9,100	9,300	9,300	9,400	9,600
Outflow[b]	800	900	900	900	900	900	900	900	900	900	900
Inflow – ITT entrants[c]	500	500	400	500	500	500	500	500	500	600	600
Inflow – other entrants[d]	400	400	500	500	600	600	600	500	500	500	500
Total inflow	900	900	900	1,000	1,000	1,100	1,100	1,000	1,000	1,100	1,100
Net balance	+100	0	0	+100	+100	+200	+200	+100	+100	+200	+200

Source: DfES (adapted).

a Figures have been rounded to nearest 100.

b Retirements and teachers moving out of the maintained sector.

c Includes entrants through employment based routes.

d Teachers returning to the maintained sector, or new to the maintained sector (ie not newly qualified).

Table 9.5 provides a projection that the DCSF has carried out concerning the numbers of mathematics specialist teachers up to 2014/15. It indicates that following a further dip in the numbers of mathematics teachers, there will be a recovery so that by 2014/15 there are expected to be as many mathematics teachers as there were estimated to be in 2004/05. As is the case for the projections for physics and chemistry teachers, the underlying assumptions upon which this projection is based are unclear. Notably, the 'stock' level quoted for 2005/06 is higher than the figure of 21,126 mathematics specialist teachers identified by the NFER (2006) report. Further, actual recruitment onto mathematics ITT courses is currently higher than that indicated in the projection, which raises a question as to how the figures in the projection have been calculated.

In addition to concerns over this projection, it is not at all clear how the figures in this projection relate to the specific *Next Steps* target, and whether any thought has been given to amending the target in light of the introduction of a second mathematics GCSE course in England from 2010, notwithstanding the fact that secondary rolls are due to fall over the next decade.

Table 9.5 Projection for number of mathematics teachers based on modelling carried out in March 2006[a]

	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Stock	24,300	24,100	23,800	23,600	23,700	23,800	23,900	24,000	24,100	24,100	24,300
Outflow[b]	2,300	2,400	2,400	2,400	2,400	2,400	2,300	2,300	2,200	2,200	2,200
Inflow – ITT entrants	900	900	1,100	1,400	1,400	1,300	1,300	1,300	1,100	1,200	1,200
Inflow – other entrants[c]	1,200	1,200	1,100	1,100	1,200	1,100	1,100	1,100	1,000	1,200	1,200
Total inflow	2,100	2,100	2,200	2,500	2,500	2,500	2,500	2,400	2,200	2,400	2,500
Net balance	–200	–300	–200	+100	+100	+100	+200	+100	0	+200	+300

Source: DfES (adapted).

a Figures have been rounded to nearest 100.

b Retirements and teachers moving out of the maintained sector.

c Teachers returning to the maintained sector, or new to the maintained sector (ie not newly qualified).

9.5 An alternative model for use in England for mathematics teachers

The TSM does not show clearly how it will enable achievement of the *Next Steps* targets relating to the numbers of mathematics lessons being taught by specialist mathematics teachers as the 'stock' does not distinguish between specialist and non-specialist teachers of mathematics, and it is assumed that the entire stock is deployed in the teaching of mathematics. A more complex model constructed by Education Data Surveys Ltd incorporates both these factors in order to predict necessary recruitment targets between now and 2014 (the end of the *Science and Innovation Investment Framework*), comparing outputs from the model when using the DCSF's staffing surveys and the more recent NFER report. The aim therefore is to model how a demand-led system would drive supply targets.

For the purposes of the following model (table 9.6), a specialist mathematics teacher is taken to be one who holds a qualification with a significant mathematics content. The best available approximations for the numbers of full-time mathematics teachers in service in maintained secondary schools in England come from the DfES's 2002 Secondary School Curriculum and Staffing Survey, published by the DfES in its 2006 volume 'Statistics of Education: School workforce in England (including teachers' pay for England and Wales)' (DfES 2006, table D9) and the NFER (2006) report.

These estimates are adjusted to take account of employment-based routes into teaching and other routes into teaching and the new estimates (2,800, DfES; 3,600, NFER) are adjusted to take account of 30% wastage (caused by 10% of trainees failing to complete their training and a further 20% of people leaving teaching a year post-qualification), to give the total number of PGCE students required per year to meet the Treasury targets (3,640, DfES; 4,680, NFER). Finally, adjusting for the six recruitment cycles left between 2007/08 and 2012/13, and excluding the numbers of recruits that may potentially train as mathematics teachers, for instance through completing employment-based enhancement or extension courses or through retraining) gives final annual estimates for the numbers of mathematics PGCE trainees as 2,957 (based on DfES figures) and 3,130 (based on the NFER study).

Comparing these figures with the numbers of mathematics acceptances (let alone entrants) to teacher training (cf. table 4.4), and notwithstanding drop-out, shows that even the lower of the two estimates has never been reached during the past 6 years. Under either scenario the challenge appears monumental. Moreover, the latest (June) figures from the current recruitment round (for course entry in September 2007) show that the number of applicants to mathematics PGCE courses in England is 7.6% down on the equivalent figures for last year, indicating not only that once again is the DCSF is unlikely to meet its recruitment target, but that the Government faces a steep uphill struggle to meet its longer-term expectations.

Table 9.6 Recruitment to mathematics PGCE courses required to meet the *Next Steps* targets

STOCK: Full-time teachers in maintained secondary schools.
Percentage of subject periods taught to year groups 7–13 holding a post-A-level qualification in that subject

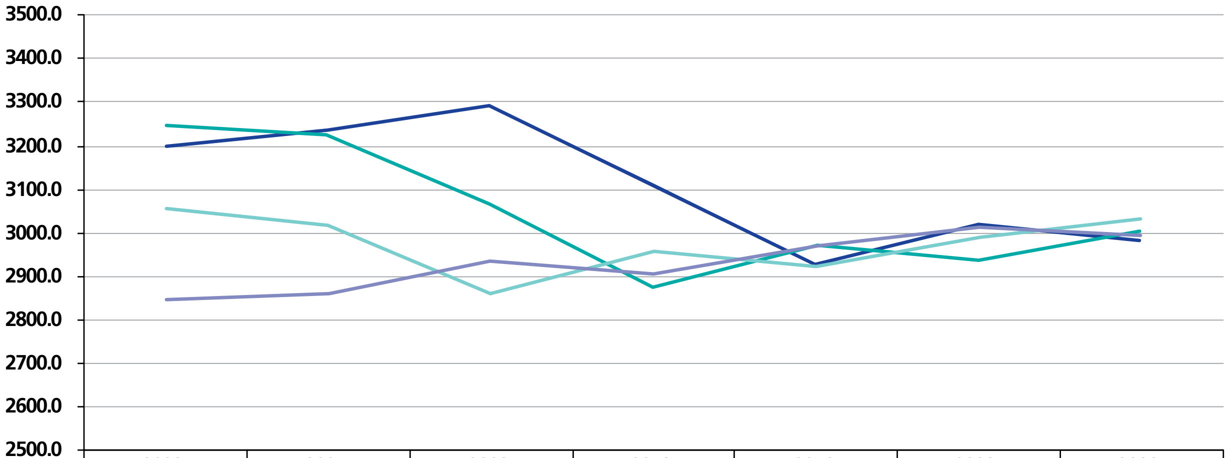
	Percentages						Total periods taught in a year
	Degree	BEd	CertEd	PGCE	Other qual.	No qual.	
Highest qualification in Mathematics (DfES V02/2006 (England), table 9)	52 ± 1	17	8	10	1	12	630,000
Highest qualification in mathematics (NFER, Moor *et al.* 2006)	47	14	5	18	5	12	

DEMAND: Requirements modelled on DfES and NFER figures (see above) in relation to *Next Steps* targets

	DfES data	NFER data	Descriptions
	5	5	(a) Average mathematics lessons a week (see V02/2006)
	28	28	(b) Periods (estimated) taught per week by a teacher
	81,900	107,100	(c) Number of lessons taught in a year by teachers without appropriate qualification (= % teachers with other/no qualification x 630,000)
	13%	17%	Percentage of teachers unqualified to teach the subject (other qualification, no qualification).
	2,925	3,825	(d) Number of teachers required to replace those unqualified to teach the subject assuming 28 periods per week per teacher = (c)/(b)
	2,800	3,600	(e) Recruitment into ITT needed = (d) – estimated recruits from EBR and other sources
PGCE trainees required to meet target	3,640	4,680	(f) PGCE recruitment target for mathematics specialists = (e) + 30%(e) (assuming 10% non-completion of ITT and 20% non-completion of induction year.
Annual increase needed to meet PGCE target	607	780	(g) Annual increase needed for the 6 years between 2007/8 and 2012/13, assuming no retraining of existing teachers = (f)/6
Actual target for ITT intake, mathematics	2,350	2,350	(h) Targets set by DCSF for 06/07 recruitment into mathematics ITT (assuming these remain constant until 2012/13)
Suggested new target for ITT intake, mathematics	2,957	3,130	(i) Proposed new targets to meet *Next Steps* targets = (g) + (h)
Possible shortfall	927	1,100	(j) Possible shortfall assuming highest ITT recruitment to date (2030 in 2004/05, (DfES,TS/TEA(ITTC)050)) is the maximum achieved = (i) – 2030

Source: Adapted from Education Data Surveys Ltd.

Figure 9.1 Age projection (England) (2003–2028)



	2003	2004	2008	2013	2018	2023	2028
0–4	2848.2	2858.6	2936.8	2903.3	2971.0	3013.7	2993.4
5–9	3054.4	3018.2	2861.8	2953.9	2920.6	2988.5	3031.2
10–14	3245.4	3227.5	3064.7	2874.9	2967.1	2933.9	3001.8
15–19	3202.3	3237.9	3292.4	3114.4	2925.0	3017.3	2984.3

Source: ONS (England and GOR population, table 10).

9.6 Targets, projections and the future

Any projection regarding the future size and teaching capacity of the specialist science and mathematics workforce needs to take account of the fact that during the next decade, the secondary school population is set to fall, as figure 9.1 shows.

Historically, the traditional response of Government to this situation has been to reduce recruitment targets. While this may seem to make good economic sense, given the acute and chronic shortages of science and mathematics teachers, and the Government's desire to increase young people's access to separate sciences' tuition, it is important that there should be no let up in efforts to recruit the chemistry, physics and mathematics teachers that are so desperately needed.

Indeed, efforts to increases recruitment in these subjects should be stepped up to ensure that there are adequate numbers of science and mathematics teachers including enough to provide specialist teaching support 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. Such an approach should help drive up the quality of new entrants into the profession, as there is likely to be greater pressure to accept, possibly less suitable people from a smaller pool of candidates if targets are reduced and the message that fewer teachers are required is promulgated.

Conclusions

i. Despite increases in the numbers of applicants to PGCE courses in science and mathematics, recruitment targets set by the Training and Development Agency for Schools have consistently been missed. In mathematics, these targets have generally been missed by 15% or more each year since 2000/01.

ii. The precise basis (including the underlying assumptions) on which the UK Government determines its recruitment targets is unclear.

iii. The credibility of the recruitment targets is undermined by the fact that they have been consistently missed.

iv. While the Teacher Supply Model is clearly highly sophisticated, it is not clear how it has informed the projections from the DCSF of future trends in the numbers of specialist physics, chemistry and mathematics teachers.The basis of the DCSF's projections of future numbers of physics, chemistry and mathematics teachers requires explanation. The latter projection does not appear to be a direct response to the relevant *Next Steps* target.

v. The clear and present need for science and mathematics teachers means that the future predicted fall in secondary rolls should not result in the Government reducing targets for recruiting people into science and mathematics initial teacher training.

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 physics, chemistry 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.

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.

Chapter 9. Workforce planning for science and mathematics teachers

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.

Acronyms

AGR	Association of Graduate Recruiters
ASE	Association for Science Education
BA	Bachelor of Arts
BA	British Association for the Advancement of Science
BEd	Bachelor of Education
BSc	Bachelor of Science
CaSE	Campaign for Science & Engineering in the UK
DCSF	Department for Children, Schools and Families
DENI	Department for Education, Northern Ireland
DES	Department for Education and Science
DfEE	Department for Education and Employment
DfES	Department for Education and Skills
DoH	Department of Health
DTI	Department for Trade and Industry
EBITT	Employment-based initial teacher training
EDS	Education Data Surveys Ltd
EBR	Employment-based route
FE	Further Education
GFEC	General Further Education Colleges
GOR	Government Office Region
GTC	General Teaching Council
GTP	Graduate Teacher Programme
GTTR	Graduate Teacher Training Registry
HEFCW	Higher Education Funding Council for Wales
HMT	Her Majesty's Treasury
ISC	Independent Schools Council
ISSP	Independent–State School Partnership
ITT	Initial teacher training
LLUK	Lifelong Learning UK
LSC	Learning and Skills Council
LSE	London School of Economics
NCETM	National Centre for Excellence in the Teaching of Mathematics
NFER	National Foundation for Educational Research
NUT	National Union of Teachers
PGCE	Postgraduate Certificate in Education or Professional Graduate Certificate in Education
PGDE	Postgraduate Diploma in Education
RTP	Registered Teacher Programme
Ofsted	Office for Standards in Education
OTTP	Overseas Trained Teacher Programme
OU	The Open University
QAA	Quality Assurance Agency for Higher Education
QLFS	Quarterly Labour Force Survey
QUB	Queen's University Belfast
QTS	Qualified Teacher Status
SCITT	School-centred initial teacher training
SFC	Sixth form college
SHEFCE	Scottish Higher Education Funding Council
SLC	Science Learning Centre
SSCSS	Secondary School Curriculum and Staffing Survey
STEM	Science, technology, engineering and mathematics
TDA	Training and Development Agency for Schools
TES	*Times Educational Supplement*
TTA	Teacher Training Agency
UAS	Undergraduate Ambassadors Scheme
UCAS	Universities and Colleges Admissions Service
UCET	Universities Council for the Education of Teachers
UCL	University College London

Appendix

Chapter 1

Table A1.1 Numbers of 16–18 year old A-level candidates across education sectors in England (all subjects) (1999/2000–2004/05)[a]

	1999/2000[b]	2000/01	2001/02	2002/03	2003/04	2004/05
Comprehensive schools[c]	99,091	103,512	110,129	115,088	116,721	116,452
Selective maintained schools	17,951	18,373	18,265	18,844	19,322	19,980
All maintained schools	117,042	121,885	128,394	133,932	136,043	140,546[d]
Independent schools	35,544	34,436	32,836	34,106	34,846	33,586
Sixth form colleges and other FE sector colleges	78,765	84,692	96,692	100,633	94,368	89,503
All schools and FE colleges	231,351	241,013	257,922	268,671	265,257	263,635[e]

Source: DfES, Adapted from SFR25/2006 (final data).

a VCE A levels and Double Awards are included from 2000/01.

b For 1999/2000 a candidate is a student who attempted at least one GCE A level in the academic year. Since 2000/01, a candidate is a student who has attempted at least one GCE A level, VCE A level or VCE Double Award in summer of the academic year.

c Includes (Secondary) Modern schools.

d,e These figures are incorrect as published.

Chapter 3

Paragraphs 63–65 of the 1996/97 staffing survey state:

'The way in which information on teachers' qualifications was collected in 1996 was different to 1992. In 1992 details of up to 4 qualifications and up to 4 subjects per qualification were collected for each teacher. For each qualification teachers were required to classify each qualification subject as being a main subject or a subsidiary subject (up to two subjects could be classed as main and two as subsidiary). In 1996 details of up to 3 qualifications and up to 3 subjects per qualification were collected for each teacher, with no distinction made between the relative importance of each subject of a qualification. This means a distinction between main and subsidiary subjects cannot be identified. All qualification subjects have been considered as of equal importance for tables contained in this bulletin.'

'In 1992 teachers were asked to complete an individual teacher return, in 1996 head teachers were asked to provide a centrally completed return. This may mean that in 1996 qualification details are more likely to have been given only for subjects relevant to a teacher's teaching duties.'

'These differences may have contributed to various apparent shifts in the results between 1992 and 1996….. In 1996:

teachers appeared to be qualified in fewer subjects,

teachers appeared to be more highly qualified (in terms of level of qualifications), and

a higher proportion of teacher qualified in a subject were also teaching the subjects.'

Table A3.1 Variation in sample sizes and definitions of 'specialist' teachers in Secondary Schools Curriculum and Staffing Surveys

Year of survey	Publication reference	No. of schools invited to participate in the survey	No. of schools responding to the survey	Approximate proportion of schools in England represented by the number of respondent schools	Definition of 'specialist' teacher
1984	Department of Education and Science Statistical Bulletin 8/86, May 1986	Not known	483[a]	10%	'Table 12 shows by subject the total number of teachers with a qualification above A level or resulting from a course of in-service training lasting one-year full-time or its part-time equivalent' (p. 3) 'Teachers are counted once against each subject in which they have a post A level qualification' (table 12) 'Teacher counted once for each component subject in which qualification recorded. General/ Combined science includes two separately-recorded subjects….' (table 12, footnote 4)
1988	Department of Education and Science Statistical Bulletin 18/91	517	424	10%	'Teachers are counted once against each subject in which they have a post A level qualification' (table 14, footnote 1)
1992	Department for Education Statistical Bulletin 24/93 (December 1993)	Not stated	489	10%	'Table 14 shows the number of teachers (full or part-time) with a post A level qualification in each subject…. Teachers are shown separately against each subject in which they had a qualification….' (paragraph 27)
1996	Department for Education and Employment Statistical Bulletin 11/97 (December 1997)	553	330	Not stated[b]	'Teachers qualified in general science are treated as qualified to teach biology, chemistry, or physics. Teachers qualified in biology, chemistry, or physics are treated as qualified to teacher general science' (paragraph 2, Summary, note t)
2002	Department for Education and Skills Statistical First Release SFR25/2003 (25 September 2003)	883	209	5.4%[c]	'Teachers qualified in General Science are treated as qualified to teach Biology, Chemistry or Physics. Teachers qualified in Biology, Chemistry, or Physics are treated as qualified to teach General Science' (paragraph 12)

a The description of sampling given in the staffing survey is ambiguous. It merely states that it 'covered 483 schools, approximately 10 per cent of maintained secondary schools (including middle deemed secondary schools and sixth form colleges) in England'.

b The staffing survey does not state the proportion of maintained secondary schools in England that it covered. Based on the previous survey, it appears that the proportion must have been somewhat less than 10%.

c Based on total number of maintained secondary schools in England given in *Statistics of education: education and training statistics for the United Kingdom*, 2002 edition, table 2.1, p. 19 (London: The Stationery Office).

Table A4.1 Admissions to institutions offering biology, chemistry and physics PGCE courses (2005/06)

	Biology	Chemistry	Physics	Mathematics	Comb. Science	Env. Science	Geology	D&T	IT
Brunel University	4	4	3	30	30				17
Cambridge University	22	29	13	36				12	
Goldsmiths College	24	5	5	24	15			33	
Institute of Education, London	33	17	14	54	26				22
Keele University	22	21	12	35	9		11		30
King's College London	35	20	14	27					26
Kingston University	14	11	3	16					
Liverpool John Moores University	27	15	12		2			15	35
Loughborough University	28	9	2					20	
Oxford University	16	7	11	31					
Roehampton University of Surrey	10	4	3	23	5			33	
St Martin's College, Lancaster	17	11	12	34	8				32
Swansea Institute of Higher Education	19	16	12	52	7			26	26
Manchester Metropolitan University	67	28	17	64				20	
The Nottingham Trent University	20	8	4	28	10			39	32
The University of Birmingham	22	20	22	47					
The University of Durham	36	10	8	30					
The University of Edinburgh	19	19	19	39				13	14
The University of Hull	19	13	5	22					
The University of Manchester	31	22	16	46				20	
The University of Nottingham	45	13	8	55					
The University of Reading	17	10	6	22					21
The University of Wales, Aberystwyth	22	4	8						
The University of Warwick	34	11	5	27					14
The University of York	17	9	9	25					
University College Worcester	21	8	6	12				15	
University of Aberdeen	14	18	12	19				8	12
University of Bath	15	11	9	12		5	3		14
University of Bristol	31	18	10	29					
University of East Anglia	20	7	8	27					
University of Exeter	37	11	14	37				30	22
University of Glasgow	14	27	14	46					6
University of Leeds	45	34	15	45				26	
University of Leicester	17	3	11	17	11				
University of Newcastle upon Tyne	16	15	12	26					
University of Southampton	28	22	10	42					21
University of Strathclyde	26	40	42	120				45	30
University of Wales, Bangor	20	13	6	17					15
Total no. of admissions	**924**	**563**	**412**	**1,216**	**123**	**5**	**14**	**355**	**389**
Places accepted elsewhere	**31**	**4**	**10**	**850**	**922**	**0**	**0**	**419**	**592**

Sources: GTTR, RS database.

Table A4.2 Institutions offering one, or more than one, of the separate sciences, but not all of the separate sciences (2005/06)

	Biology	Chemistry	Physics	Math-ematics	Comb. Science	D&T	IT
University of Huddersfield	9	2		15	8	28	31
University of the West of England	22			31		40	
University of Sussex		2		21	41		
Bradford College			2	17	23		20
University of Dundee			8	20			

Sources: GTTR, RS database.

Table A4.3 Institutions offering PGCE courses in combined science (2005/06)

	Biology	Chemistry	Physics	Combined Science	Mathemat-ics
Anglia Polytechnic University				27	
Bath Spa University College				26	7
Bishop Grosseteste College				16	10
Bournemouth, Poole and Dorset East SCITT				7	7
Bradford College			2	23	17
Brunel University	4	4	3	30	30
Canterbury Christ Church University College				42	19
Cardiff, University of Wales Institute				47	25
Chiltern Training Group				7	7
Colchester Schools SCITT Consortium				7	6
Cornwall School Centred Initial Teacher Training				6	2
De Montfort University				19	18
Durham Secondary Applied SCITT				6	
Edge Hill College of Higher Education				97	44
Goldsmiths College, University of London	24	5	5	15	24
Grand Union Training Partnership (SCITT)				2	
Hastings and Rother SCITT				3	6
Institute of Education, University of London	33	17	14	26	54
Keele University	22	21	12	9	35
Kent and Medway Training (SCITT)				7	8
Leeds SCITT				8	
Liverpool Hope				32	39
Liverpool John Moores University	27	15	12	2	
London Metropolitan University				8	
The College of St Mark & St John				28	14
Mid Essex SCITT Consortium				3	4

Table A4.3 *(cont.)*

	Biology	Chemistry	Physics	Combined Science	Mathematics
Middlesbrough SCITT				5	4
Middlesex University				18	25
North East Essex Coastal Confederation ITT (SCITT)				2	4
Northampton Teacher Training Partnership				2	3
Oxford Brookes University				21	20
Roehampton University of Surrey	10	4	3	5	23
Sheffield Hallam University				61	40
South West Teacher Training (SCITT)				4	
St Martin's College, Lancaster	17	11	12	8	34
St Mary's College				27	41
Swansea Institute of Higher Education	19	16	12	7	52
Swindon SCITT				6	5
The Learning Institute				7	3
The Marches Consortium (SCITT)				5	6
The North Bedfordshire Consortium (SCITT)				4	4
The Nottingham Trent University	20	8	4	10	28
The Titan Partnership				4	5
The University of Sheffield				35	26
University College Chester				41	38
University of Brighton				20	44
University of East London				34	39
University of Gloucestershire				15	9
University of Greenwich				15	24
University of Hertfordshire				23	22
University of Huddersfield	9	2		8	15
University of Leicester	17	3	11	11	17
University of Portsmouth				33	20
University of Sunderland				42	23
University of Sussex		2		41	21
University of Wolverhampton				28	23
Total	202	108	90	1,045	994
Places accepted elsewhere	753	459	332	0	1,072

Sources: GTTR, RS database.

Table A4.4 Number of mathematics PGCE acceptances in 2005/06 among institutions that do not also offer PGCE courses in biology, chemistry and physics (separately, in two-subject combinations, or altogether)

Name of institution	Year (2005/06)
Anglia Polytechnic University	0
Bath Spa University College	7
Billericay Educational Consortium (SCITT)	0
Bishop Grosseteste College	10
Bournemouth and East Dorset SCITT Consortium	0
Canterbury Christ Church University College	19
Cardiff, University of Wales Institute	25
Central School of Speech and Drama	0
Chiltern Training Group	7
Colchester Schools SCITT Consortium	6
Cornwall School Centred Initial Teacher Training	2
De Montfort University	18
Devon Primary SCITT	0
Devon Secondary Teacher Training Group (SCITT)	0
Dorset Teacher Training Partnership (SCITT)	0
Edge Hill College of Higher Education	44
Essex Primary Schools Training Group (SCITT)	0
Forest Independent Primary Collegiate (SCITT)	0
Gloucestershire Initial Teacher Education Partnership (SCITT)	0
Grand Union Training Partnership (SCITT)	0
High Force Education	0
Kent and Medway Training (SCITT)	8
King Alfred's Winchester	0
Leeds Metropolitan University	0
Leeds, Trinity and All Saints College	27
Liverpool Hope	39
London Arts Consortium	0
London Diocesan Board for Schools (SCITT)	0
Mid Essex SCITT Consortium	4
Middlesex University	25
Newman College of Higher Education	0
Newport, University of Wales College	0
North East Essex Coastal Confederation ITT (SCITT)	4
North East Partnership	0
Northampton Teacher Training Partnership	3
Northumbria DT Partnership	0

Table A4.4 (*cont.*)

Name of institution	Year (2005/06)
Nottingham Primary Schools (SCITT)	0
Oxford Brookes University	20
Pilgrim Partnership	0
Portsmouth Primary SCITT	0
Primary Catholic Partnership	0
Reading College and School of Arts and Design	0
Royal Academy of Dance	0
Sheffield Hallam University	40
Shire Foundation (SCITT)	0
Somerset Teacher Education Programme SCITT Consortium	0
South West Teacher Training (SCITT)	0
St Mary's College	41
Swindon SCITT	5
The Borough of Poole SCITT	0
The Jewish Primary School Consortium (SCITT)	0
The Marches Consortium (SCITT)	6
The National SCITT in Outstanding Primary Schools	0
The North Bedfordshire Consortium (SCITT)	4
The Thames Primary Consortium	0
The Titan Partnership	5
The University of Sheffield	26
The Wandsworth Primary School Consortium	0
Trinity College Carmarthen	0
University College Chichester	22
University College Northampton	0
University of Brighton	44
University of Central England in Birmingham	18
University of Derby	0
University of East London	39
University of Gloucestershire	9
University of Greenwich	24
University of Hertfordshire	22
University of Northumbria at Newcastle	0
University of Plymouth	13
University of Portsmouth	20
University of Sunderland	23
University of Wolverhampton	23

Table A4.4 (*cont.*)

Name of institution	Year (2005/06)
West Mercia Primary Schools SCITT	0
West Midlands Consortium	0
York St John	0
Birmingham CREDIT	0
Langdale SCITT	0
Leeds SCITT	0
Leicester and Leicestershire SCITT	0
The Learning Institute	3
Middlesbrough SCITT	4
Staffordshire University	0
University College Chester (until 2004 Chester)	38
SCITT in East London Schools/ East London Schools' SCITT	0
London Metropolitan University/University of North London until 2004	0
London South Bank University/South Bank University until 2004	22
Gateshead 3-7 SCITT	0
Marjon – The College of St Mark & St John (previously S59 The College of St Mark & St John)	14
Bournemouth, Poole and Dorset East SCITT (new institution in 2005 application cycle)	7
Durham Secondary Applied SCITT (new institution in 2005 application cycle)	0
Hastings and Rother SCITT (new institution in 2005 application cycle)	6
Grand total	**746**

Sources: GTTR, RS database.

Table A4.5 Total numbers of chemistry, physics and mathematics first degrees awarded to UK-domiciled students (1998/99–2004/05)

Subject (JACS coding)	1998/99	1999/2000	2000/01	2001/02	2002/03	2003/04	2004/05
(F1) Chemistry total	3,454	3,174	3,104	3,000	2,760	2,552	2,532
(F3) Physics total	2,225	2,211	2,325	2,178	2,054	1,997	2,083
(G1) Mathematics total	4,477	4,303	4,274	4,251	4,067	4,296	4,118

Sources: Data from figure 5.5 in *A degree of concern? UK first degrees in science, technology and mathematics*. The Royal Society (2006).

Table A4.6 Populations of England, Wales and Scotland (2000–2006)

Mid-year estimates Numbers (thousands)	England	Wales	Scotland
2000	49,233	2,907	5,063
2001	49,450	2,910	5,064
2002	49,647	2,923	5,055
2003	49,856	2,938	5,057
2004	50,093	2,952	5,078
2005	50,432	2,959	5,095
Projections			
2006	50,714	2,977	5,108

Source: ONS (http://www.statistics.gov.uk/statbase/Expodata/Spreadsheets/D9542.xls).

Table A4.7 Male and female applicants and acceptances to primary PGCE courses across England, Wales and Scotland (2001–2006)

	Gender	Applicants and Acceptances	2001	2002	2003	2004	2005	2006
England	Male	Applicants	2,320	2,780	3,453	3,529	3,606	3,679
		Acceptances	954	1,084	1,306	1,428	1,411	1,460
	Female	Applicants	11,876	13,913	15,993	16,649	16,353	16,295
		Acceptances	5,660	6,690	7,540	7,889	7,702	7,418
Wales	Male	Applicants	225	282	326	356	300	311
		Acceptances	92	97	87	102	99	96
	Female	Applicants	863	1,200	1,361	1,297	1,023	943
		Acceptances	449	430	451	426	377	385
Scotland	Male	Applicants	120	294	288	368	388	499
		Acceptances	40	67	65	138	186	217
	Female	Applicants	824	1,987	1,890	1,953	2,149	2,344
		Acceptances	294	480	547	807	1,153	1,275

Sources: GTTR, RS database.

Table A4.8 Physics A-level entries in England 1996–2006 by gender

	Total	Males	Females	% of total entries (males)	% of total entries (females)
1996	28,400	22,443	5,957	79.0%	21.0%
1997	28,777	22,630	6,147	78.6%	21.4%
1998	29,672	23,119	6,553	77.9%	22.1%
1999	29,552	22,831	6,721	77.3%	22.7%
2000	28,191	21,795	6,396	77.3%	22.7%
2001	28,031	22,010	6,021	78.5%	21.5%
2002	27,860	21,541	6,319	77.3%	22.7%
2003	26,278	20,370	5,908	77.5%	22.5%
2004	24,606	19,223	5,383	78.1%	21.9%
2005	24,094	18,920	5,174	78.5%	21.5%
2006(R)[a]	23,657	18,687	4,970	79.0%	21.0%

Source: DCSF.

a Revised data from the DfES published in SFR02(07) on 10 January 2007.

Table A4.9 Numbers and distribution of female and male applicants and acceptances to secondary PGCE courses in biology, chemistry, physics and combined/general sciences across England, Wales and Scotland (2001–2006)

Subject	Year	Applicants				Acceptances			
Biology		Female	%	Male	%	Female	%	Male	%
England	**2001**	1,051	*63%*	622	*37%*	573	*68%*	275	*32%*
	2002	1,007	*63%*	594	*37%*	616	*68%*	288	*32%*
	2003	939	*61%*	598	*39%*	600	*65%*	319	*35%*
	2004	979	*65%*	532	*35%*	592	*70%*	253	*30%*
	2005	971	*62%*	589	*38%*	565	*66%*	297	*34%*
	2006	948	*65%*	518	*35%*	630	*70%*	273	*30%*
Wales	**2001**	73	*62%*	44	*38%*	48	*68%*	23	*32%*
	2002	54	*56%*	43	*44%*	29	*48%*	32	*52%*
	2003	52	*59%*	36	*41%*	39	*58%*	28	*42%*
	2004	61	*62%*	38	*38%*	43	*65%*	23	*35%*
	2005	44	*52%*	40	*48%*	33	*54%*	28	*46%*
	2006	59	*65%*	32	*35%*	45	*59%*	31	*41%*
Scotland	**2001**	86	*72%*	33	*28%*	31	*86%*	5	*14%*
	2002	146	*73%*	55	*27%*	42	*79%*	11	*21%*
	2003	121	*67%*	59	*33%*	21	*88%*	3	*13%*
	2004	147	*66%*	77	*34%*	33	*77%*	10	*23%*
	2005	184	*66%*	96	*34%*	57	*78%*	16	*22%*
	2006	217	*71%*	88	*29%*	46	*79%*	12	*21%*

Table A4.9 *(cont.)*

Chemistry	Year	Applicants				Acceptances			
		Female	%	Male	%	Female	%	Male	%
England	**2001**	348	*48%*	377	*52%*	228	*56%*	181	*44%*
	2002	352	*46%*	409	*54%*	233	*53%*	210	*47%*
	2003	347	*49%*	360	*51%*	251	*55%*	205	*45%*
	2004	380	*51%*	365	*49%*	252	*57%*	190	*43%*
	2005	398	*52%*	369	*48%*	236	*54%*	198	*46%*
	2006	396	*55%*	330	*45%*	267	*57%*	205	*43%*
Wales	**2001**	21	*49%*	22	*51%*	16	*47%*	18	*53%*
	2002	12	*35%*	22	*65%*	14	*37%*	24	*63%*
	2003	18	*51%*	17	*49%*	21	*55%*	17	*45%*
	2004	21	*49%*	22	*51%*	20	*56%*	16	*44%*
	2005	11	*37%*	19	*63%*	11	*33%*	22	*67%*
	2006	16	*41%*	23	*59%*	17	*45%*	21	*55%*
Scotland	**2001**	27	*64%*	15	*36%*	11	*61%*	7	*39%*
	2002	44	*53%*	39	*47%*	21	*72%*	8	*28%*
	2003	57	*52%*	53	*48%*	35	*61%*	22	*39%*
	2004	57	*57%*	43	*43%*	46	*69%*	21	*31%*
	2005	81	*52%*	74	*48%*	64	*59%*	44	*41%*
	2006	94	*56%*	73	*44%*	82	*66%*	42	*34%*

Physics	Year	Applicants				Acceptances			
		Female	%	Male	%	Female	%	Male	%
England	**2001**	87	*25%*	256	*75%*	58	*28%*	148	*72%*
	2002	107	*25%*	318	*75%*	68	*27%*	182	*73%*
	2003	121	*25%*	358	*75%*	90	*28%*	226	*72%*
	2004	125	*24%*	387	*76%*	89	*30%*	211	*70%*
	2005	131	*25%*	389	*75%*	82	*27%*	219	*73%*
	2006	129	*26%*	363	*74%*	95	*31%*	208	*69%*
Wales	**2001**	6	*21%*	23	*79%*	3	*15%*	17	*85%*
	2002	8	*27%*	22	*73%*	7	*25%*	21	*75%*
	2003	13	*41%*	19	*59%*	14	*39%*	22	*61%*
	2004	6	*18%*	27	*82%*	6	*17%*	29	*83%*
	2005	7	*25%*	21	*75%*	8	*28%*	21	*72%*
	2006	7	*22%*	25	*78%*	4	*15%*	23	*85%*
Scotland	**2001**	9	*39%*	14	*61%*	7	*70%*	3	*30%*
	2002	12	*18%*	56	*82%*	12	*24%*	37	*76%*
	2003	17	*23%*	57	*77%*	16	*25%*	47	*75%*
	2004	19	*20%*	74	*80%*	15	*21%*	57	*79%*
	2005	28	*24%*	91	*76%*	22	*22%*	76	*78%*
	2006	32	*28%*	84	*72%*	25	*29%*	61	*71%*

Table A4.9 (cont.)

Combined/General Sciences	Year	Applicants				Acceptances			
		Female	%	Male	%	Female	%	Male	%
England	**2001**	569	*55%*	464	*45%*	386	*61%*	250	*39%*
	2002	532	*53%*	464	*47%*	368	*56%*	294	*44%*
	2003	565	*51%*	549	*49%*	448	*57%*	344	*43%*
	2004	671	*54%*	572	*46%*	496	*58%*	355	*42%*
	2005	780	*54%*	656	*46%*	558	*58%*	400	*42%*
	2006	818	*55%*	656	*45%*	609	*58%*	441	*42%*
Wales	**2001**	46	*56%*	36	*44%*	33	*62%*	20	*38%*
	2002	42	*44%*	53	*56%*	31	*57%*	23	*43%*
	2003	55	*57%*	41	*43%*	28	*50%*	28	*50%*
	2004	64	*54%*	54	*46%*	28	*55%*	23	*45%*
	2005	68	*60%*	45	*40%*	31	*57%*	23	*43%*
	2006	55	*55%*	45	*45%*	33	*61%*	21	*39%*

Sources: GTTR, RS database.

Table A4.10 Numbers and distribution of female and male applicants and acceptances to secondary PGCE courses in biology, chemistry and physics (combined) (2001–2006)

	Year	Applicants				Acceptances			
		Female	%	Male	%	Female	%	Male	%
England	**2001**	2,055	*54%*	1,719	*46%*	1,245	*59%*	854	*41%*
	2002	1,998	*53%*	1,785	*47%*	1,285	*57%*	974	*43%*
	2003	1,972	*51%*	1,865	*49%*	1,389	*56%*	1,094	*44%*
	2004	2,155	*54%*	1,856	*46%*	1,429	*59%*	1,009	*41%*
	2005	2,280	*53%*	2,003	*47%*	1,441	*56%*	1,114	*44%*
	2006	2,291	*55%*	1,867	*45%*	1,601	*59%*	1,127	*41%*
Wales	**2001**	146	*54%*	125	*46%*	100	*56%*	78	*44%*
	2002	116	*45%*	140	*55%*	81	*45%*	100	*55%*
	2003	138	*55%*	113	*45%*	102	*52%*	95	*48%*
	2004	152	*52%*	141	*48%*	97	*52%*	91	*48%*
	2005	130	*51%*	125	*49%*	83	*47%*	94	*53%*
	2006	137	*52%*	125	*48%*	99	*51%*	96	*49%*
Scotland	**2001**	124	*67%*	62	*33%*	49	*77%*	15	*23%*
	2002	202	*57%*	150	*43%*	75	*57%*	56	*43%*
	2003	195	*54%*	169	*46%*	72	*50%*	72	*50%*
	2004	223	*53%*	194	*47%*	94	*52%*	88	*48%*
	2005	293	*53%*	261	*47%*	143	*51%*	136	*49%*
	2006	343	*58%*	245	*42%*	153	*57%*	115	*43%*

Sources: GTTR, RS database.

Table A4.11 Numbers and distribution of female and male applicants and acceptances to secondary PGCE courses in mathematics across England, Wales and Scotland (2001–2006)

	Year	Applicants				Acceptances			
		Female	%	Male	%	Female	%	Male	%
England	**2001**	794	*41%*	1,123	*59%*	523	*48%*	576	*52%*
	2002	847	*38%*	1,402	*62%*	589	*45%*	732	*55%*
	2003	1,029	*39%*	1,585	*61%*	745	*45%*	918	*55%*
	2004	1,111	*38%*	1,807	*62%*	715	*43%*	959	*57%*
	2005	1,326	*41%*	1,928	*59%*	842	*47%*	936	*53%*
	2006	1,229	*44%*	1,591	*56%*	855	*48%*	920	*52%*
Wales	**2001**	53	*46%*	61	*54%*	42	*51%*	41	*49%*
	2002	51	*39%*	81	*61%*	42	*44%*	53	*56%*
	2003	66	*46%*	78	*54%*	52	*54%*	45	*46%*
	2004	65	*42%*	89	*58%*	49	*51%*	48	*49%*
	2005	54	*35%*	100	*65%*	40	*40%*	60	*60%*
	2006	66	*49%*	70	*51%*	53	*54%*	45	*46%*
Scotland	**2001**	27	*50%*	27	*50%*	17	*53%*	15	*47%*
	2002	76	*46%*	88	*54%*	63	*56%*	49	*44%*
	2003	85	*47%*	94	*53%*	76	*53%*	68	*47%*
	2004	123	*43%*	160	*57%*	117	*46%*	136	*54%*
	2005	129	*40%*	197	*60%*	106	*43%*	140	*57%*
	2006	145	*44%*	183	*56%*	120	*47%*	136	*53%*

Sources: GTTR, RS database.

Chapter 5

Table A5.1 Turnover rates (percentages of employment) of LEA full-time permanent secondary teachers by main teaching subject (1997–2005)

Subject	1997	1998	1999	2000	2001	2002	2003	2004	2005
Mathematics	13.0	8.7	10.4	15.1	15.3	14.4	12.5	11.7	12.4
IT	8.5	7.5	12.6	17.6	18.8	25.7	21.8	24.2	28.7
Physics	14.0	9.4	12.1	15.4	14.2	15.5	11.4	11.3	10.9
Chemistry	13.1	8.9	10.8	13.5	15.4	13.6	12.6	10.7	11.2
Biology	13.9	8.5	11.1	15.4	18.6	16.1	14.3	13.4	13.6
Other sciences	9.4	6.6	7.9	11.5	13.5	12.8	11.4	12.0	11.7
Modern foreign languages	14.1	11.0	11.3	15.4	15.8	14.1	11.4	10.0	9.2
English	12.1	9.0	10.1	14.7	16.4	15.6	12.8	12.5	12.5
History	10.0	7.2	7.7	10.1	10.5	11.1	9.4	10.1	9.5
Social sciences	10.0	5.5	7.9	11.0	10.7	12.8	8.9	12.6	11.3
Geography	10.8	6.6	7.5	10.4	10.7	11.4	9.7	10.0	8.8
Religious education	12.2	8.8	10.2	15.4	15.6	14.3	13.5	11.9	11.7
Design & technology	10.3	7.5	7.5	10.9	11.3	11.7	10.2	9.3	10.3
Commercial & business studies	11.0	7.4	7.4	12.5	12.8	10.9	11.5	11.5	9.7
Art, craft or design	12.1	6.3	7.4	9.4	10.3	10.6	7.8	7.6	7.2
Music	14.2	10.5	13.4	18.5	16.3	16.8	13.2	13.3	15.7
Physical education	7.6	6.2	7.3	10.4	12.7	11.8	10.9	10.0	11.2
Special educational needs	10.3	7.0	6.3	8.9	9.3	10.3	8.9	9.7	8.2
Other and combined	8.5	6.1	7.2	11.1	11.8	11.5	12.8	20.6	26.4
All subjects	11.4	8.2	9.4	12.7	13.5	12.5	11.5	11.4	11.6

Source: LGAR 2006.

Chapter 7

Table A7.1 Unfilled vacancies in maintained secondary schools in England as a percentage of teachers in post (2000–2006)

	2000	2001	2002	2003	2004	2005	2006
All sciences[a]	0.6	1.6	1.4	1.2	1.0	1.1	0.9
Mathematics	1.2	2.1	1.9	1.5	1.4	1.2	1.1
English	0.7	1.8	1.5	1.3	1.0	0.9	0.9
History	0.2	0.5	0.5	0.5	0.4	0.3	0.4
Geography	0.3	0.6	0.9	0.6	0.6	0.6	0.4
Total vacancies across all subjects[b]	1,140	2,530	2,350	1,940	1,530	1,440	1,230

Sources: DfES, Form 618g (SFR15/2007).

a Vacancy data for combined sciences and separate sciences are aggregated.

b Data are rounded.

Table A7.2 Total numbers of unfilled vacancies across all subjects in England (2000–2007)

Main teaching subject	2000[a]	2001[b]	2002[c]	2003[d]	2004[e]	2005[f]	2006[g]	2007[h] (p)
All sciences	**156**	**398**	**380**	**310**	**230**	**250**	**210**	**210**
Mathematics	**233**	**410**	**390**	**320**	**260**	**230**	**200**	**200**
IT	56	124	100	110	100	90	90	90
Languages	109	245	190	150	90	70	40	60
English	129	360	320	290	190	180	170	140
Drama	23	59	60	40	30	30	20	20
History	12	39	40	40	30	30	30	20
Social sciences	8	15	20	10	10	10	10	10
Geography	25	51	70	50	50	40	30	20
Religious education	36	96	90	80	80	60	50	40
D&T	110	206	210	160	140	120	80	90
Commercial/business studies	17	41	30	40	20	30	20	20
Art, craft or design	24	47	60	40	40	40	40	20
Music	35	78	80	60	50	50	60	30
Physical education	30	102	110	90	80	90	60	60
Careers	3	9	0	0	0	0	0	0
Other main and combined subjects	137	197	200	50	130	120	120	100
Total vacancies across all subjects	**1,143**	**2,477**	**2,350**	**1,940**	**1,530**	**1,440**	**1,230**	**1,130**
All science vacancies as a proportion of all vacancies	13.6%	16.1%	16.2%	16.0%	15.0%	17.4%	17.1%	18.6%
Mathematics vacancies as a proportion of all vacancies	20.4%	16.6%	16.6%	16.5%	17.0%	16.0%	16.3%	17.7%

Source: DfES; p, provisional. Note that since 2002, figures have been rounded to the nearest 10.

a Data for 2000 are extracted from 'Statistics of education: teachers in England (including teachers pay for England and Wales) 2001', p. 88, published by the DfES on 22 February 2002. The source of the data is given as DfES annual 618g survey and National Assembly for Wales STATS3 survey.

b Data for 2001 are extracted from 'Statistics of education: teachers in England (including teachers pay for England and Wales) 2001', p. 88, published by the DfES on 22 February 2002.

c Data for 2002 are extracted from SFR18/2002, 'Teachers in service and teacher vacancies', January 2002 (revised), published on 5 August 2002.

d Data for 2003 are extracted from SFR23/2003, 'School workforce in England (including pupil teacher ratios and pupil adult ratios)', January 2003 (revised), published on 9 September 2003.

e Data for 2004 are extracted from SFR34/2004, 'School workforce in England (including pupil teacher ratios and pupil adult ratios)', January 2004 (revised), published on 23 September 2004.

f Data for 2005 are extracted from SFR34/2005, 'School workforce in England (including pupil teacher ratios and pupil adult ratios)', January 2005 (revised), published on 28 September 2005.

g Data for 2006 are extracted from SFR37/2006, 'School workforce in England (including pupil teacher ratios and pupil adult ratios)', January 2006 (revised), published on 28 September 2006.

h Data for 2007 are extracted from SFR15/2007, 'School workforce in England (including pupil teacher ratios and pupil adult ratios)', January 2006 (provisional), published on 26 April 2007.

Table A7.3 Permanent departmental head and assistant headship posts advertised in England (all Government Office Regions) in the *TES* and on Eteach.com (2006–2007)

		Year	
Subject	Post type	2006	2007 (January–July)
Biology	Departmental Head	90	29
Chemistry	Departmental Head	78	59
Physics	Departmental Head	101	70
Science – general	Departmental Head Assistant Head	522 13	488 1
Science – other	Departmental Head	2	1
Mathematics	Departmental Head Assistant Head	642 23	555 7
English	Departmental Head Assistant Head	596 22	535 3
Geography	Departmental Head	209	189
History	Departmental Head	171	135
Modern foreign languages	Departmental Head Assistant Head	359 3	288 0
Grand total		**2,831**	**2,360**

Sources: Education Data Surveys Ltd, RS database.

Table A7.4 Numbers of vacancies in the sciences in maintained secondary schools in Wales as at January for the years 2003/04–2005/06

	2003/04	2004/05	2005/06
Biology	1	2	1
Chemistry	0	0	0
Physics	3	2	3
Other science	7	8	6
Mathematics	11	11	8
Computer studies	2	1	1
Total across all subjects	**67**	**67**	**58**

Source: *Schools in Wales: general statistics 2006* (National Assembly of Wales).

Table A7.5 Vacancies in maintained secondary schools in Wales between 1 January and 31 December for the years 2003–2005 (data for 2003 and 2004 are provisional)

Subject	No. of posts advertised			No. of applications received			No. of posts where an appointment was made			% of posts appointed		
	2003[a]	2004[b]	2005[c]	2003	2004	2005	2003	2004	2005	2003	2004	2005
Biology	19	18	19	186	179	181	18	17	17	94.7	94.4	94.7
Chemistry	23	12	20	172	99	178	23	12	20	100	100	100
Physics	57	29	28	663	196	176	56	27	26	98.2	93.1	92.9
General science	39	83	86	206	822	855	36	81	86	92.3	97.6	100
Mathematics	95	83	93	699	704	923	85	80	87	89.5	96.4	93.5
Total vacancies across all subjects	**848**	**795**	**907**	**7,477**	**7,635**	**8,728**	**802**	**754**	**869**	**94.6**	**94.8**	**95.8**

Source: National Assembly of Wales.

a Data from SDR59/2004, published 31 August 2004.

b Data from SDR76/2005, published 31 August 2005.

c Data from Schools in Wales: General Statistics 2006.

Table A7.6 Vacancies in science and mathematics subjects in secondary maintained schools in Scotland (2002–2007)

	2002	2003	2004	2005	2006	2007	Vacancies as % of each subject's full teaching complement (2007)
Biology	6	6	14	20	15	12	1.1
Chemistry	6	7	11	19	18	11	1.1
Physics	12	19	16	25	9	10	1.1
General science	5	3	6	3	5	1	0.6
Mathematics	41	34	60	70	33	50	2.0
Total no. of vacancies across all subjects	**663**	**654**	**790**	**1,164**	**774**	**695**	

Source: Teacher vacancies and probationer allocations 2007, 26 June 2007 (Scottish Executive). Vacancy data not available for Aberdeenshire in 2002 or 2003.

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