PHYSICS IN SCHOOLS AND COLLEGES
Teacher Deployment and Student Outcomes

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Executive Summary

The Gatsby Charitable Foundation commissioned the Centre for Education and Employment Research at the University of Buckingham to conduct a survey in 2005 of the current state of physics education for 14-18 year-olds in England and Wales.

Key Findings

- Physics is in danger of disappearing as an identifiable subject from much of state education, through redefinition to general science and teacher shortage.

- Nearly a quarter (23.5%) of 11-16 schools had no teacher at all who had studied physics to any level at university.

- In 26.8% of state schools one in four or fewer of the teachers of physics had studied the subject to any level at university, including in 56.3% of the secondary moderns, 40.1% of the 11-16 comprehensives and 17.5% of the up-to-18 comprehensives. None of the grammars, sixth-form colleges or FE colleges, and only 7.8% of the up-to-18 independents, found themselves in this position.

- Overall, in the schools and colleges of England and Wales, 37.7% of the teachers of physics/physical processes to 14-18 year-olds had physics as their main subject of qualification.

- Teachers' expertise in physics as measured by qualification is the second most powerful predictor of pupil achievement in GCSE and A-level physics after pupil ability.

- Pupils' opportunity to participate in physics and be taught by teachers well-qualified in the subject is reduced if they attend an 11-16 school.

- The age profile of physics teachers qualified in physics is skewed with almost double (31.1%) aged 51and over as 30 and under (16.6%).

- The stock of physics teachers qualified in physics is diminishing. Whereas 39.0% of the leavers in 2004 had physics as their main subject, this was true of only 32.8% of newly appointed. More of the 21-30 year-old teachers of physics hold a degree in biology than have one in physics.

- Teachers of physics in science specialist schools were, on average, less well qualified in physics than the teachers of physics in arts or language specialist schools.

- About a tenth (10.8%) of the teachers in schools with a degree in physics were not teaching physics. Nearly three-quarters of those (72.3%) were teaching maths or computing.

- A quarter (25.1%) of the teacher trainees with a degree in physics were training to be maths teachers rather than physics teachers.

- It is estimated that the physics teacher training output needs to be raised from the current 450 to 750 a year to replace the teachers retiring and otherwise leaving, and enable all schools during the next five years to have the prospect of at least a quarter of their teachers of physics being qualified in the subject.

Aims
The brief specified that the research should take into account maintained and independent schools, and sixth form and further education colleges, with a view to describing and analysing:

- the subject qualifications of physics teachers;
- the deployment of physics teachers;
- GCSE and A-level results;
- any correlations between the qualifications of physics teachers and examination results;
- the supply of, and requirement for, physics teachers.

Methodology
A questionnaire designed to be completed by heads of department to elicit information on science courses, teacher details, pupil numbers, examination results, and views on the recruitment, training and deployment of teachers was devised through piloting in four maintained schools. Variants were developed for independent schools, sixth form colleges and further education colleges through fieldwork in these institutions also.

Population frames for maintained and independent schools, and sixth form and further education colleges, in England and Wales were constructed from published sources. This led to the identification of 4,318 institutions. A questionnaire was sent in late February 2005 to the headteacher/principal of all the institutions. From the 974 returns a sample of 432 institutions was drawn matching the population on type of institution, region, size, type, funding category, age range, gender mix and specialism and other characteristics. The structured sample of 432 schools and colleges was the source of the 10 per cent sample of physics teachers which is the basis of this report.

Findings
Teachers of Physics Our 10 per cent sample when scaled up to the population indicated that there were 18,230 practising teachers of physics. Of these, 11,580 were teaching up to GCSE level and 6,650 up to A-level; 7960 were major teachers (principal task teaching physics/physical processes) and 10,270 minor (contributing some lessons); with 2,910 being major teachers to A-level. Younger teachers were more likely to be female with degrees in biology than the older teachers, and new appointments continued this trend. Male teachers with degrees in physics were more likely to be teaching after the age of 60, frequently on part-time fixed-term contracts. Over ten per cent of teachers with degrees in physics were not teaching the subject. They were mainly teaching maths or computing/IT.

Schools and Colleges: Teachers who have studied physics at university are spread very unevenly across the schools and colleges, so student opportunities to engage with the subject vary considerably. Grammar schools, up-to-18 independent schools, sixth form and further education colleges employed mainly major teachers in physics with degrees in physics.

Comprehensive schools, particularly the up-to-16 schools, tended to have a large number of teachers teaching physics as part of science, relatively few of whom had university-level qualifications in physics. Over half the physics teachers in the colleges were aged over 50, as were nearly 40 per cent of those in the grammars and up-to-18 independents.

Participation: Opportunity to study physics varies with background and the general ability level of the school. Pupils from less affluent homes tend to be concentrated in those schools least likely to offer GCSE physics and with teachers having the least physics expertise. Opportunities in FE where attainment is generally on the low side appear to do little to rescue the situation. Proportionally the grammar schools were the most successful in attracting students to A-level physics followed by the up-to-18 independents. The largest groups come through the sixth form colleges.

Performance: Pupil performance at GCSE and A-level varies across the institutions in parallel with teacher qualifications, with the exception of the further education colleges. A number of schools, particularly the grammars and independents, enter the more able pupils for the physics GCSE. In spite of some of the brightest students being diverted to physics *per se,* the grammars and independents also did best on the dual science award. The pattern is repeated at A-level.

Common Threads: Teacher qualifications in physics and pupil performance in the subject are correlated. In part, this is because the most highly qualified teachers and the best performing pupils are to be found in the same schools, but even with the school effect controlled statistically the relationship holds. Factor analysis reveals a common thread linking pupil participation and performance in physics to school/college type, pupil ability and background, and the physics expertise of the major teachers of physics. Multiple regression shows school type and pupil ability to be the best predictors of participation in GCSE and A-level physics. Pupil ability, too, is the best predictor of GCSE and A-level physics results, with teachers' qualifications in physics as a strong second.

Views from the Schools and Colleges: Six main themes emerged: the difficulties experienced by many schools, especially those in unfavourable circumstances, in recruiting sufficient teachers with physics expertise; the impact on quality; the looming wave of retirements; the underpinning for sixth-form studies; whether science or physics was the subject; and attracting and retaining students. In some schools and colleges physics is thriving and we ask what are they doing right and can any lessons be learned from them to improve the situation generally?

***Teacher Supply**:* Recruitment to physics PGCE courses has improved in response to government incentives, but it is still below the level that was regarded as a crisis in the 1980s. The gap has been filled largely by biologists aided by the redefinition of the sciences to 'science'. Not all physics graduates training to teach do so to teach physics – a quarter train as maths teachers.

***Teacher Demand**:* Current levels of physics teacher training output are barely sufficient to maintain the status quo, itself widely regarded as unsatisfactory.

In nearly a quarter of 11-16 schools, and 450 schools overall, there was no teacher who has studied physics to any level at university. Another 520 schools had one in four or fewer of their teachers of physics with some university experience in the subject. Altogether 26.8 per cent of state schools, but none of the grammars, sixth form colleges or FE colleges, and hardly any of the independents, were in this position. The under-representation occurred mainly in 11-16 comprehensives (40.1%) and 11-18 comprehensives (17.5 %), and also the few remaining secondary moderns (56.3%). It is estimated that the physics teacher training output needs to be increased from 450 to 750 per year to offer all schools in the next five years the prospect of having at least a quarter of their teachers of physics with a qualification in physics, and to cope with the increase in retirements among existing staff.

Issues

1. Should physics be more clearly identifiable as a school subject pre-16 and, if so, in what form?

2. Should the science community review the relative merits of the separate sciences and integrated science at GCSE as a basis for educating the physicists of the future?

3. Should maintained schools be allowed the same freedom as independent schools to offer any combination of the separate sciences?

4. What can be done to ensure a more balanced representation of biology, chemistry and physics teachers within GCSE science?

5. Should the schools and colleges in which physics is thriving be studied to see what lessons can be learned from them?

6. Given that the opportunities for a young person with the talent and interest to study physics to a high level vary so widely across the educational system, what can be done to move towards a more level playing field?

7. What can be done to increase the output of newly-trained physics teachers qualified in physics to replace the well-qualified teachers who are leaving and to enable all state schools to have the prospect of appointing at least some physics teachers qualified in the subject?

8. Why do so many physicists train to become maths teachers?

9. Should we be thinking of linking physics with maths in PGCE courses rather than with biology?

Conclusion

Physics in schools and colleges is at risk both through redefinition and lack of teachers with expertise in the subject. Many of those with degrees in physics came through the education system when physics was more clearly identifiable as a subject and they will be retiring soon. Present shortages will be exacerbated. If physics is to survive in schools, both as essential education and a platform for higher level of study and research, there is an urgent need to address these issues.

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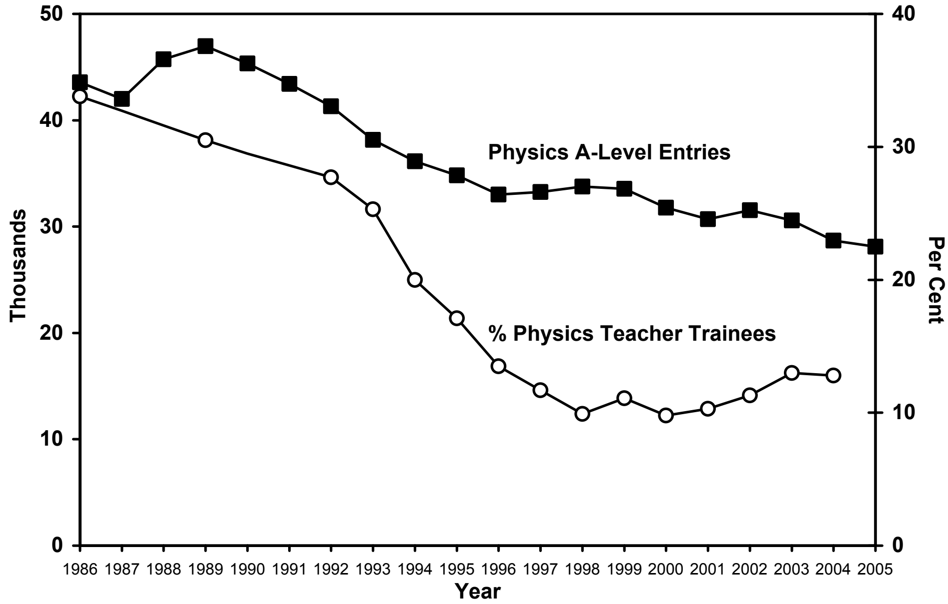
1. Introduction

1.1 One of the most striking and disturbing trends in English education over the past two decades has been the decline in entries for the A-level physics examination. Since 1986 A-level entries overall have risen by nearly a quarter (23.1 per cent), but physics take-up has declined by more than a third (35.5 per cent). Over the same period there has been difficulty in recruiting sufficient physics teachers. From a third of those training to be science teachers in 1986, the physics trainees in 2004 amounted to only one in eight. Chart 1.1 shows these trends and prompts the question: are they related and, if so, in what ways? What is the relationship, for example, between the availability and expertise of physics teachers and pupil participation and performance in physics at A-level?

Chart 1.1: Physics A-Level Entries[1] and Teacher Trainees[2]



1. Joint Council for Qualifications, UK entries irrespective of age.
2. Graduate Teacher Training Registry, trainees on physics PGCE course as a percentage of all science PGCE trainees.

1.2 Unfortunately, the data are not there to tackle these questions directly. Data on teacher trainees have been used in Chart 1, because nationally there is no good information on the numbers and qualifications of teachers of physics and how they are deployed. The Department of Education (in its various guises) did conduct staffing surveys every four years from 1984 to 1996, and then again in 2002. In these surveys information was collected on the teachers in maintained secondary schools in England in terms of both the subject taught and subject qualifications. On both definitions, there seem to have been dramatic declines. In terms of subject taught, the number of physics teachers appears to have fallen from 12,600 in 1984 to 4,700 in 2002. The numbers of teachers with a post-A-level qualification in physics was shown as declining from 19,400 in 1984 to 10,400 in 1996 (the 2002 figure was not published).

1.3 But the number of biology teachers appears to have decreased similarly when there are good reasons for supposing that the situation in that subject is very different – for example, there has been a sharp increase in teacher trainees with a background in the biological sciences (Smithers and Robinson, 2000). It seems likely, therefore, that the numbers emerging may reflect definitional changes and changes in the structure of school science education more than the availability of teachers to teach the subjects. With the introduction of the national curriculum in 1988 the subject category up to the age of 16 in maintained schools became ‘science’ rather than the separate sciences. It seems probable that as the notion of ‘science’ as the subject took hold, increasingly only teachers with some involvement in specialist sixth-form teaching will have been characterised by the schools as, say, physics or biology teachers. Hence the considerable decreases reported for teachers in all the sciences.

Present Project

1.4 It is against the background of seemingly a serious problem and the dearth of information that the Gatsby Charitable Foundation commissioned the Centre for Education and Employment Research at the University of Buckingham to conduct a survey in 2005 to discover how many teachers of physics there are and what is their expertise? It further requested the Centre to examine what bearing this had on the courses offered and the participation and performance in physics of pupils at Key Stage 4 and students aged 16-18?

1.5 The brief specified that the research would take into account maintained and independent schools, and sixth form and further education colleges, in England and Wales with a view to describing and analysing**:**

- the subject qualifications of physics teachers;
- the deployment of physics teachers;
- GCSE and A-level results;
- any correlations between the qualifications of physics teachers and science/physics examination results;
- the supply of, and requirement for, physics teachers.

Methods

1.6 The methods adopted are fully described in Appendix A. A questionnaire to be completed by heads of science/physics departments seeking information on science courses, teacher details, pupil numbers, examination results, and views on the recruitment, training and deployment of teachers was devised through piloting in four maintained schools and four independent schools. Variants were developed for sixth form colleges and further education colleges through visits to these institutions.

1.7 Population frames for maintained and independent schools and sixth form and further education colleges in England and Wales were obtained from *Statistics of Education, Schools in England, 2004*, *Schools in Wales, General Statistics, 2004*, *The Education Authorities Directory and Annual 2004*, *The ISC Guide to Accredited Independent School, 2004 Edition*, and the sixth form colleges’ website. This resulted in the identification of the 4,318 institutions listed by type in Chart 1.2.

Chart 1.2: Population and Sample

Institutions	National		Sample	
	N	%	N	%
Comprehensive	3,034	70.3	304	70.4
Grammar	164	3.8	16	3.7
Secondary Modern	159	3.7	16	3.7
Independent	598	13.8	60	13.9
Sixth Form College	110	2.5	11	2.5
FE College	253	5.9	25	5.8
Total	**4,318**	**100.0**	**432**	**100.0**

1.8 A questionnaire, with a supporting letter from the Institute of Physics, the Royal Society, the Association for Science Education and the Royal Academy of Engineering, was sent in late February 2005 to the headteacher/principal of all the institutions with a covering letter asking them if they were willing to participate, to forward the package enclosed to the appropriate head of department. A reminder was sent a month later.

1.9 Altogether 974 completed questionnaires were received. A comparison of the A-level entries reported by these institutions with the actual entries by school type recorded by the Joint Council on Qualifications indicates that the respondents were more likely to come from among those with the higher numbers of entrants (see Chart A1, page 56). As we shall be showing, the questionnaire was probably easier and less time-consuming for these schools to complete because they tended to have fewer but better qualified teachers concentrating on the teaching of physical processes/physics. Schools with the better results were also more likely to want to tell people about it. The situation could, therefore, be worse than we describe.

1.10 The initial unevenness in the returns has been counteracted by constructing a 10 per cent sample that matches the national picture as closely as possible. Chart 1.2 shows the composition of that sample by institution. The sample also corresponded closely with the following national distributions:

- for maintained schools, region, size, type, funding category, age range, gender mix and specialism;
- for independent schools, region, size, type, age range, gender mix, day or boarding, and membership of particular association;
- and for sixth form and further education colleges, region and numbers of students 16-18.

1.11 The sampling method and the extent of the correspondence with national parameters are described in detail in Appendix B. The sample of 432 schools and colleges yielded the 10 per cent sample of physics teachers which is the basis of this report.

The Report

1.12 We begin our account of the findings, in Chapter 2, with a quantitative description, derived from the 10 per cent sample, of the teachers who are teaching physics to 14-18 year-olds in England and Wales. We then focus in Chapter 3 on differences between the types of schools and colleges and show how unevenly the available teachers qualified in physics are distributed. In Chapter 4, we look at how pupil participation and performance in physics also varies across these institutions.

1.13 Common threads emerged in these three chapters. In Chapter 5 we attempt to tease out those threads by factor analysis. But the key question was: what part do teacher qualifications play in pupil participation and performance in physics? We address this through product-moment correlation, partial correlation holding school/college type constant, and multiple regression. We conclude that the teachers' expertise in physics has an important bearing on how well pupils do in GCSE and A-level physics and are able to quantify the extent of the relationship.

1.14 In Chapter 6 we allow the schools and colleges to speak for themselves. We collect together their views on the recruitment and deployment of physics teachers, the quality of the teachers, concerns about the age profile, the underpinning for A-level courses, whether physics or science is the subject, and attracting and retaining students post-16. In some schools and colleges physics is thriving and we ask what is it that they are doing right and can any lessons be learned to improve the general situation.

1.15 In Chapter 7 we consider the trends in the recruitment of physics teachers showing that although there has been some recovery in recent years teacher training output is still below the levels that were regarded as a crisis in the 1980s. We also attempt to estimate how many extra trainees would be required so that every school would have the opportunity of appointing at least one teacher with physics expertise, bearing in mind the impending retirements. Chapter 8 draws together the various lines of evidence to identify a number of the emerging issues in the provision of physics education.

2. Physics Teachers

2.1 The 432 institutions in our ten per cent sample of the education system providing for the education of 14-18 year-olds in England and Wales yielded 1,823 teachers reported by the heads of department as teachers of physics. Scaling up from the sample to the population suggests that there were 18,230 across the system. Charts 2.1 and 2.2 show the qualifications of these teachers in two ways, first, the highest level of qualification of the teacher in physics and, secondly, the main subject qualification of the teacher. The two tabulations are linked in that having at least a combined or joint honours degree was adopted as the criterion for taking physics as the main subject qualification.

Chart 2.1: Highest Qualification in Physics

Level	Total	Major	Minor
PhD	2.7	4.5	1.3
MSc/MPhys	4.2	6.2	2.6
Natural Sciences II	0.5	1.3	0.0
Single Hons Degree	25.8	44.6	11.3
Joint/Comb Hons	4.5	6.2	3.2
Degree Subsidiary	11.8	13.2	10.8
A-level	26.9	16.3	35.1
GCSE	23.0	7.5	35.0
Not Known	0.5	0.3	0.8
Population	18,230	7,960	10,270
Per Cent	100.0	43.7	56.3

Chart 2.2: Main Subject of Qualification

Subject	Total	Major	Minor
Physics[1]	37.7	62.4	18.6
Chemistry	12.8	4.2	19.4
Biology	22.5	9.3	32.8
Engineering/Technology	6.3	9.3	4.3
Geology/Geography	2.7	1.9	3.3
Mathematics	0.7	0.6	0.8
Medicine/Vet Science	3.6	2.2	4.7
Other Physical Science	2.6	3.5	1.8
Other	2.6	1.3	3.7
Not known	8.4	5.3	10.5
Population	18,230	7,960	10,270
Per Cent	100.0	43.7	56.3

1. At least a joint honours degree in physics, elsewhere in the report we lower the bar and distinguish those who have studied physics to any level at university from those with only experience at A-level or GCSE. From Chart 2.1 we can see this raises the proportion qualified in physics to nearly half (49.5 per cent).

2.2 The charts show that, overall, half the teachers of physics had studied the subject to no more than A-level and that for only 37.7 per cent was it their subject of qualification in the sense of having taken it to at least joint or combined honours degree standard.

2.3 For some teachers, teaching physics, or the physical processes strand of national curriculum science was the major part of their school week, while for others it was a matter of contributing a few lessons here and there. The questionnaires asked for a breakdown of the school week (or more precisely the teaching cycle since for some this runs over two weeks) for each teacher, and we have distinguished between those spending at least 36 per cent of their time teaching physics/physical processes to 14-18 year-olds and the rest. For full-timers this was a proportion of their time; for part-timers it was as a proportion of the school week. The threshold is set low to allow for the time spent elsewhere on administration, teaching Key Stage 3 science, teaching other sciences and subjects, and non-contact time. On this basis, just under half the teachers were major teachers of physics. As we show in chapter 3, some institutions had mainly major teachers, often there was a mixture, but some schools had only minor physics teachers on our criterion.

2.4 Charts 2.1 and 2.2 also show the population categorised in this way. We can see that most of those qualified only to A-level were minor teachers, but nevertheless a quarter of the major teachers had studied the subject no higher. The most common subject qualification of the minor teachers was biology (32.8 per cent). Among the major teachers, 62.4 per cent had physics as their subject qualification and a further 9.3 held degrees in engineering or technology. Very few of the teachers of physics, either major or minor, held maths degrees.

Chart 2.3: Highest Qualification in Physics by Level Taught

Level	GCSE	GCSE/ A-level	A-level
PhD	1.1	4.6	12.2
MSc/MPhys	2.0	7.1	12.2
Natural Sciences II	0.0	1.6	1.1
Single Hons Degree	11.3	52.4	46.7
Joint/Comb Hons	3.3	6.5	5.6
Degree Subsidiary	11.7	12.5	13.3
A-level	35.7	12.7	8.9
GCSE	34.9	2.6	0.0
Population	11,580	5,730	920
Per Cent	63.5	31.4	5.0

2.5 The teachers of physics can also be classified according to the level to which they teach physics. Charts 2.3 and 2.4 show a broad division by examination course taught. Nearly two-thirds (63.5 per cent) of the teachers of physics/physical processes taught the subject to GCSE level. Most of the rest spanned GCSE and A-level, but 5 per cent, mainly in the sixth form colleges and further education colleges, were specialist A-level teachers. Over 70 per cent of the GCSE-only teachers had no qualification in physics beyond A-level. Over a third had, themselves, only taken the subject as a GCSE, part of a GCSE or to O-level. The most common qualification of the GCSE-only teachers of physics (and this spans the whole range of GCSEs including the physics GCSE) was biology (33.4 per cent), followed by chemistry (18.5 per cent), with physics itself third (17.8 per cent).

Chart 2.4: Main Subject of Qualification by Physics Taught

Subject	GCSE	GCSE/ A-level	A-level
Physics	17.8	71.8	76.9
Chemistry	18.5	3.0	3.3
Biology	33.4	3.0	1.1
Engineering/Technology	3.5	12.0	7.7
Geology/Geography	3.3	1.6	1.1
Mathematics	0.5	1.1	1.1
Medicine/Vet Science	5.3	0.9	0.0
Other Physical Science	2.4	2.5	5.5
Other	3.6	1.1	0
Not Known	11.5	2.3	3.3
Population	11,580	5,730	920
Per Cent	63.5	31.4	5.0

2.6 Those with degrees in physics were concentrated in the GCSE/A-level and A-level categories. Among the A-level specialists, 76.9 per cent held a physics degree and only 8.9 per cent had not studied the subject beyond A-level. Over 70 per cent of the GCSE/A-level group held a physics degree, but with 15.3 per cent having gone no further than A-levels. It looks as though the A-level courses at least are generally taught by teachers with expertise in the subject.

Chart 2.5: Physics Teaching by Subject of Qualification

Subject	GCSE		GCSE/A-level		A-level	
	Major	Minor	Major	Minor	Major	Minor
Physics	33.5	13.2	74.7	57.3	78.9	13.2
Chemistry	9.2	20.9	2.4	6.3	0.0	20.9
Biology	25.5	35.8	2.1	11.5	1.4	35.8
Engineering/Technology	3.3	3.7	12.2	11.5	9.9	3.7
Geology/Geography	2.5	3.7	1.7	1.0	1.4	3.7
Mathematics	0.8	0.5	0.6	3.1	0.0	0.5
Medicine/Vet Science	5.4	5.3	0.9	1.0	0.0	5.3
Other Physical Science	4.2	1.8	2.8	1.0	5.6	1.8
Other	2.5	4.0	0.0	2.1	0.0	0.0
Not Known	13.0	11.2	1.7	5.2	2.8	5.0
Population	5,050	6,530	2,510	3,220	400	520
Per Cent	27.7	35.8	13.8	17.7	2.2	2.9

2.7 But this is not the case at Key Stage 4 in all schools. Chart 2.5 shows that while nearly all of the major teachers for A-level physics have either a degree in physics, engineering/technology, or other physical sciences (like material science or astronomy), the minor teachers at GCSE – the largest group and over a third of the physics teaching force – were most often biologists or chemists. Teachers from a wide variety of other subjects also contributed lessons in physical processes, including some with degrees in sociology, law and philosophy.

Age

2.8 It is often said that the average age of teachers of physics is higher than that of teachers of other subjects. But leaving aside those over 60 who have continued or have been invited back because of their expertise in physics, Chart 2.6 shows the teachers tend to be spread more or less evenly across the age bands. However, common impression is correct. The clue is in the subject qualifications at the different ages. While the proportion with a degree in physics increases across the age bands, the percentage with a degree in biology decreases. More of the 21-30 year-old teachers of physics hold a degree in biology than have one in physics. The population of physics teachers qualified in physics is not renewing itself.

Chart 2.6: Subject Qualifications of Teachers of Physics by Age

Subject	21-30	31-40	41-50	51-60	61+
Physics	30.7	33.9	36.6	48.1	63.0
Chemistry	12.8	14.6	11.6	12.1	11.1
Biology	32.9	24.6	22.0	12.9	3.7
Engineering/Technology	5.2	6.2	6.9	7.1	0.0
Geology/Geography	2.7	3.2	2.6	2.4	0.0
Mathematics	0.8	0.6	0.4	1.2	0.0
Medicine/Vet Science	1.6	3.6	6.3	2.4	3.7
Other Physical Science	1.9	2.4	2.8	3.3	0.0
Other	3.0	2.6	2.6	2.4	0.0
Not Known	8.4	8.4	8.1	8.1	18.5
Population	3,710	5,050	4,960	4,240	270
Per Cent	20.3	27.7	27.2	23.3	1.5

Chart 2.7: Age by Subject Qualification

Age	Physics	Chemistry	Biology	Eng/Tech
21-30	16.6	20.3	29.7	16.7
31-40	24.9	31.6	30.2	27.2
41-50	26.4	24.7	26.5	29.8
51-60	29.6	22.1	13.3	26.3
61+	2.5	1.3	0.0	0.0
Population	6,880	2,330	4,100	1,150
Per Cent	37.7	12.8	22.5	6.3

2.9 The point is perhaps more forcefully made by turning the data around, as in Chart 2.7. Thirty per cent of the physics graduates are over 50 against 13.3 per cent of the biology graduates, but in the youngest group the situation is reversed – 30 per cent of the biology graduates compared with 16.6 per cent of those in physics.

New Appointments

2.10 The trend in replacing physicists with biologists is continuing. Chart 2.8 shows that there had been turnover of 16.9 per cent in teachers of physics in 2004. While not all new appointments are the recently qualified, most are young with 43.8 per cent aged 30 or under. The subject qualifications of the new appointments are compared with those of existing staff in Chart 2.8 and again the drift from physics to biology is apparent.

Chart 2.8: New Appointments

Subject	New	Not New
Physics	32.8	39.0
Chemistry	15.4	12.4
Biology	27.0	22.2
Engineering/Technology	5.1	6.5
Geology/Geography	4.4	2.5
Mathematics	0.3	0.8
Medicine/Vet Science	2.4	3.7
Other Physical Science	1.7	2.7
Other	2.0	2.8
Not Known	8.9	7.4
Population	3,080	15,150
Per Cent	16.9	83.1

Gender

2.11 Proportionally more of the new appointments are female – 18.9 per cent against 15.5 per cent – and, as Chart 2.9 shows, female teachers of physics tend to be younger. While, overall, nearly 60 per cent of the teachers of physics are male, among those aged 21-30 females are in the majority (53.3 per cent).

Chart 2.9: Age by Gender

Age	Males	Female
21-30	16.2	26.2
31-40	26.3	29.7
41-50	28.3	25.7
51-60	26.7	18.2
61+	2.5	0.1
Population	10,710	7,520
Per Cent	58.7	41.3

2.12 Chart 2.10 shows that female teachers of physics are nearly twice as likely as the male teachers to hold a degree in biology. Indeed, more have a degree in biology than in physics.

Chart 2.10: Qualifications by Gender

Subject	Male	Female
Physics	42.6	31.1
Chemistry	13.0	12.5
Biology	16.0	31.6
Engineering/Technology	8.1	3.7
Geology/Geography	2.6	2.8
Mathematics	0.8	0.5
Medicine/Vet Science	2.6	4.9
Other Physical Science	3.2	1.7
Other	2.6	2.5
Not Known	8.4	8.5
Population	10,710	7,520
Per Cent	58.7	41.3

Contract

2.13 The great majority of the teachers of physics are on full-time permanent contracts, but there are interesting differences with age. Chart 2.11 shows those who are 61 or over tend to be on part-time fixed-term contracts suggesting that they have been appointed for their physics expertise (see Chart 2.5) perhaps in response to recruitment difficulties. Younger teachers are the most likely to be given full-time fixed-term contracts. This has become an increasingly common practice in schools as they seek to retain flexibility in the face of falling rolls. Those on part-time fixed-term contracts were most likely to be aged 31-40. Two-thirds were female – perhaps not unconnected with family responsibilities - reversing the proportions on the other types of contract.

Chart 2.11: Contract by Age

Age	Full Time Permanent	Full Time Fixed Term	Part Time Permanent	Part Time Fixed Term
21-30	21.4	30.5	5.5	9.5
31-40	26.9	31.6	35.9	19.0
41-50	26.9	22.4	31.7	38.1
51-60	23.8	10.5	24.1	14.3
61+	1.0	5.3	2.8	19.0
Population	15,790	770	1,460	210
Per Cent	86.6	4.2	8.0	1.2

Not Teaching Physics

2.14 In addition to the 6,880 teachers with at least a joint honours degree teaching physics, the structured sample revealed that there were 830 teachers qualified in the subject to that standard who were not teaching the subject at all. Thus over ten per cent of the physicists in schools are not teaching physics. Chart 2.12 shows that nearly half were teaching maths and another quarter were teaching computing/IT. As we shall be seeing in Chapter 7, currently about a quarter of those with physics degrees who train to be teachers are actually training for maths teaching, so the switch may have occurred from the outset. Movement between physics and maths is almost entirely one way with few maths graduates contributing to the teaching of physics.

Chart 2.12: Qualified[1] in Physics But Not Teaching Physics

Subject Taught/Role	N	%
Mathematics	380	45.8
Computing IT	220	26.5
Design & Technology	30	3.6
Other Science	60	7.2
Other Subject	100	12.0
Headteacher	40	4.8
Total	830	100

1. At least joint honours degree in physics.

2.15 In Chart 2.13 we compare those in schools who are qualified in physics but not teaching it with the teachers of physics who hold at least a joint honours degree. Those not teaching physics are more likely to be male and to hold a senior position than their physics-teaching counterparts. The shortage of physics teachers has led to schools offering enhancements and this tends to give physics graduates a head start in obtaining senior posts.

Chart 2.13: Teachers Compared

Characteristic	Not Teaching Physics	Teaching Physics[1]
%Male	74.7	69.2
%Full Time Permanent	94.0	86.7
%New	7.4	13.5
%Higher Degree In Education	6.1	4.1
%SMT	33.7	9.2
% At least HoD	61.5	43.0
Population	830	6,880
Per Cent	10.8	89.2

1. With at least a joint honours degree in physics since this is the criterion for being classified as qualified in physics but not teaching the subject.

Resumé

2.16 Our 10 per cent sample of schools and colleges teaching physics/physical processes to 14-18 year-olds indicates that there was in February 2005 a population of 18,230 teachers of physics. Of these, 11,580 were teaching up to GCSE level and 6,650 up to A-level; 7960 were major teachers and 10,270 minor; with 2,910 being major teachers to A-level.

2.17 Younger teachers were more likely to be female with degrees in biology than the older teachers. New appointments were consistent with this shift. Male teachers with degrees in physics were more likely to be teaching after the age of 60, frequently on part-time fixed-term contracts probably filling a gap in expertise.

2.18 Over ten per cent of teachers with degrees in physics were not teaching the subject. They were mainly teaching maths or computing/IT. Compared with those teaching physics they were more likely to be male and to occupy a senior administrative role including 5 per cent who were headteachers.

3. School and College Differences

3.1 Teachers with expertise in physics are spread very unevenly across the schools and colleges teaching the subject to 14-18 year-olds. This is not just a matter of numbers though it is worth noting that 80 per cent of the teachers of physics in our sample are located in what we are still calling comprehensive schools (though we will look at differences with specialism later). In describing the characteristics of the population of physics teachers we are, therefore, mainly describing the situation in comprehensive schools. But beyond the gross distribution of the teachers there are clearly important differences between the institutions.

Table 3.1: Teachers by School/College

Institution	Schools/ Colleges	Physics Teachers	Teachers per School	Major	Minor	Ratio of Major to Minor
Comprehensive to 16	137	576	4.4	161	415	0.39
Comprehensive to 18	167	884	5.3	394	490	0.80
Secondary Modern	16	72	4.5	31	41	0.76
Grammar	16	58	3.6	39	19	2.05
Independent to 16	9	11	1.2	3	8	0.38
Independent to 18	51	158	3.1	108	5	2.16
Sixth Form College	11	29	2.6	26	3	8.67
FE College	25	35	1.4[1]	34	1	34.00
Total	**432**	**1,823**	**4.2**	**796**	**1,027**	**0.78**

1. Six of the 25 FE colleges did not offer physics and in one other there were no takers.

3.2 Chart 3.1, for example, shows that there is a wide range in the number of teachers of physics per school/college. This is, in part, a matter of size and we will be exploring this further in Chapter 4. But it is also to do with how the schools perceive physics – as a distinctive subject requiring teachers with particular expertise, or as science that can be taught by any science teacher. The proportions of major to minor teachers of physics varies widely across the institutions from 0.4 in the up-to-16 schools to 34.0 in the further education colleges. There were more minor teachers than major in the comprehensive schools and secondary moderns, with the reverse in the grammar schools, the up-to-18 independent schools, the sixth form colleges and the further education colleges.

3.3 These differences in practice – and perhaps attractiveness to physics graduates – are underlined by the qualifications of the teachers of physics in the different types of school and college shown in Charts 3.2 and 3.3. The grammar schools, up-to-18 independent schools, the sixth form colleges and the further education colleges have around two-thirds or more of their physics teachers holding at least a joint honours degree in the subject, whereas the comprehensive schools, secondary modern schools and up-to-16 independents have a half or more with at most A-level physics. In the cases of the 11-16 comprehensives and the secondary moderns, around a third or more of the teachers had taken the subject no higher than GCSE. Those teachers would be most likely to have studied biology. The degree of expertise in physics that pupils encounter in school clearly varies widely and this could be expected to have some bearing on the pupils' interest for, and aspiration in, the subject. We take this up in Chapter 4

Chart 3.2: Degree Subjects of those Teaching Physics/Physical Processes

Subject	Comprehensive to 16	Comprehensive to 18	Sec Mod	Gram	Independent to 16	Independent to 18	Sixth Form College	FE College
Physics	23.6	39.3	18.1	65.5	18.2	64.6	75.9	80.0
Chemistry	13.7	14.7	15.3	0.0	18.2	7.0	3.4	0.0
Biology	27.6	23.4	38.9	0.0	54.5	5.7	3.4	0.0
Engineering/Technology	3.1	6.8	4.2	13.8	9.1	12.0	13.8	5.7
Geology/Geography	3.3	2.6	1.4	3.4	0.0	1.9	0.0	2.9
Mathematics	0.3	0.7	0.0	1.7	0.0	1.9	0.0	2.9
Medicine/Vet Science	5.4	2.9	5.6	1.7	0.0	2.5	0.0	0.0
Other Physical Science	2.6	1.9	8.3	1.7	0.0	3.8	0.0	5.7
Other	3.1	2.9	1.4	1.7	0.0	0.6	0.0	0.0
Unknown	17.2	4.8	6.0	10.3	0.0	0.0	3.4	2.9
Population of Teachers	5,760	8,840	720	580	110	1,580	290	350
Per Cent	31.6	48.5	3.9	3.2	0.6	8.7	1.6	1.9

Chart 3.3: Highest Qualification in Physics

Highest Qualification in Physics	Comprehensive to 16	Comprehensive to 18	Sec Mod	Gram	Independent to 16	Independent to 18	Sixth Form College	FE College
PhD	0.7	2.7	0.0	5.4	0.0	5.7	10.3	17.1
MSc/MPhys	3.3	4.1	2.8	5.4	0.0	5.1	17.2	4.2
Natural Sciences II	0.0	0.6	0.0	1.8	0.0	2.5	0.0	0.0
Single Hons Degreee	14.8	28.0	12.5	50.0	9.1	45.6	44.8	48.6
JT/Comb Hons	4.7	4.2	2.8	5.4	9.1	5.7	3.4	5.7
Degree Subsidiary	14.3	10.0	8.3	12.5	27.3	13.3	6.9	20.0
A-level	29.7	28.6	29.2	16.1	54.5	17.7	17.2	0.0
GCSE	32.5	21.8	44.4	3.6	0.0	4.4	0.0	0.0
Population of Teachers	5,760	8,840	720	580	110	1,580	290	350
Per Cent	31.6	48.5	3.9	3.2	0.6	8.7	1.6	1.9

3.4 The average level of qualification of physics teachers in a school/college type is related to the proportion of those teachers mainly teaching physics. As we saw in Chart 3.1, and show again in a slightly different way in Chart 3.4, this differs widely across the institutions. While nearly all the teachers of physics in sixth form colleges and further education colleges have teaching the subject as their principal task, this is true of just over a quarter in the up-to-16 schools. The average level of qualification of the physics teachers is similarly distributed.

3.5 In order to feed qualification level into multivariate analysis and also summarise the level of qualifications in an institution, we have devised a scale ranging from 10 for a PhD to 1 for GCSE. On this scale a joint honours degree counts as 6 so if the average score is above this figure it shows that the typical teacher of physics in the school/college has a degree in the subject. Looking at all the teachers of physics, this is the case in the grammar schools, independent schools, sixth form colleges and further education colleges. If we think only of the major teachers, this becomes true also of the up-to-18 comprehensives, but not the up-to-16 schools or the secondary moderns. The level of qualification in physics also varies among the minor teachers. In the grammars, up-to-18 independents, sixth form colleges and further education colleges it is around the level of physics as a degree subsidiary, but for the comprehensives it is just above A-level and for the secondary moderns even below that.

Chart 3.4: Characteristics of Teachers of Physics by Institution

Qualifications and Characteristics	Comprehensive to 16	Comprehensive to 18	Sec Mod	Gram	Independent to 16	Independent to 18	Sixth Form College	FE College
% Major	28.0	44.6	43.1	67.2	27.3	68.4	89.7	97.1
Qualification Level[1]	4.2	5.2	3.9	6.8	4.7	6.5	7.5	7.6
QL Major	5.6	6.7	5.1	7.0	5.3	7.0	7.7	7.7
QL Minor	3.7	3.7	2.7	6.2	4.1	5.4	4.8	5.0
%51+	19.3	23.6	15.3	37.5	36.4	38.6	51.7	53.0
% Male	57.5	63.0	57.0	71.4	48.6	66.4	75.9	81.6
%New	17.7	16.1	15.0	12.9	5.7	15.4	10.3	7.8
%Part Time	5.9	9.3	4.7	8.9	23.8	11.1	27.9	16.2
Population of Teachers	5,760	8,840	720	580	110	1,580	290	350
Per Cent	31.6	48.5	3.9	3.2	0.6	8.7	1.6	1.9

1. Scale created from the highest level of qualification in physics ranging from 10 for a PhD to 1 for a GCSE. Six and above indicates that the average level of qualification is at least a joint or combined honours degree in physics which we have adopted as our criterion for having a physics degree.

3.6 Chart 3.4 shows the teachers also vary in other ways across the institutions. In the schools/colleges with the best qualified they tend to be older. In the cases of the sixth form and further education colleges over half are aged over 50, as are approaching 40 per cent of those in grammars and independents. In contrast, in the comprehensives and secondary moderns only around a fifth have reached this age. Male teachers are in the majority in all institution types, but the difference is most marked in those with the most highly qualified in physics. The colleges recruited fewer new staff than the schools in 2004. This is likely to reflect the falling number of students coming forward to take A-level physics, particularly in further education colleges. The greater use of part-time staff in the colleges may also be associated with this.

3.7 So far we have treated the maintained sector as consisting of comprehensive, grammar and secondary moderns, but it could be argued that these categories do not take account of current government policy which is for all maintained schools to become specialist. Of particular interest are the science schools which might be expected to play a part in boosting interest in the sciences including physics. Chart

3.5 shows that the science schools have a higher proportion of major teachers than the other school types, but they tend to be somewhat less well-qualified in physics than the teachers of physics in the arts, language and maths/computing schools. This somewhat surprising finding may be explained in part by the different origins of the specialist school types. The arts, language and the maths/computing schools are more often up-to-18 schools than the science schools. As we have seen, well qualified physics teachers tend to gravitate to schools/colleges where there is the prospect of A-level teaching. The language and maths/computing schools also included a sprinkling of grammar schools, but this is also true of the science schools.

Chart 3.5: Characteristics of Teachers of Physics by School Specialism

Characteristic	Tech	Sports	Arts	Lang	Science	Maths/ Comp	Other	Not Specialist
% Major	47.2	35.6	49.2	49.1	59.1	33.2	24.9	40.7
Qualification Level	4.9	4.7	5.7	5.5	5.1	4.6	3.7	4.4
QL Major	6.3	6.3	7.3	7.1	6.4	7.4	5.2	5.7
QL Minor	3.9	3.5	4.2	4.3	3.9	3.0	3.4	3.7
Average Age	40.0	40.0	40.2	41.9	40.6	41.5	38.2	40.7
% Male	61.9	68.8	63.1	59.9	57.8	60.6	57.0	55.8
%New	15.5	21.1	16.7	8.3	13.4	23.8	18.7	15.8
%Part Time	8.7	7.5	9.4	8.1	8.7	7.2	3.3	7.7
Number of Schools[1]	53	22	32	24	35	16	19	112
% Up-To-18	58.5	31.8	68.7	66.7	60.0	75.0	47.4	42.0

1. England only, total N=313.

3.8 Independent schools are also more varied than is commonly supposed. Chart 3.6 shows that the HMC and GSA schools tend to have teachers with degrees in physics concentrating on teaching physics.

Chart 3.6: Teachers of Physics in Independent Schools

Characteristic	HMC[1]	GSA[2]	SHMIS[3]	ISA/IAPS[4]
% Major	73.1	73.8	65.8	39.7
Qualification Level	6.9	6.5	4.4	5.4
QL Major	7.0	7.2	6.0	6.5
QL Minor	6.5	4.4	2.0	5.1
Average Age	44.0	46.3	46.5	46.6
% Male	78.3	43.7	77.5	84.6
%New	17.0	23.7	11.7	9.6
%Part Time	5.3	22.5	3.3	15.4
Number of Schools	21	20	6	13
% Up-to-18	100.0	95.0	100.0	38.5

1.Headmsters' and Headmistresses' Conference

2. Girls' Schools Association

3. Society of Headmasters and Headmistresses of Independent Schools.

4. Independent Schools Association and Incorporated Association of Preparatory Schools.

3.9 The ISA schools, which are generally not up-to-18 schools, tend to have fewer teachers of physics *per se* but those they do have usually hold degrees in physics. The few SHMIS schools are behind the rest in their levels of qualification with the minor teachers, on average, not having the subject to A-level. The Girls' Schools Association schools were the only group to have a majority of female teachers of physics. Teachers across all associations tended to be older than their counterparts in maintained schools. The GSA schools were, however, making new appointments and also employing a high proportion of part-time staff.

3.10 Girls' schools in the maintained sector were also more likely to have a majority of female teachers of physics. Chart 3.7 shows that there was a similar pattern across the maintained and independent sectors with the single-sex schools tending to have more specialist teachers of physics who were more highly qualified. This probably has something to do with their traditions, part of which has been to recognise physics as a distinctive subject. Both independent and maintained schools for the secondary age range were originally single sex and the schools still organised in this way tend to be of long standing. In the maintained sector, the single-sex schools are often grammar schools or secondary moderns, or schools that were formerly such. Among the independent schools they are mainly the HMC and GSA schools.

Chart 3.7: Characteristics of Teachers of Physics by Gender Composition of School[1]

Characteristic	Maintained			Independent		
	Boys	Mixed	Girls	Boys	Mixed	Girls
% Major	56.0	43.1	61.5	72.9	58.8	71.6
Qualification Level	5.0	4.8	5.2	6.8	6.0	6.3
QL Major	6.4	6.3	6.9	7.5	6.5	7.1
QL Minor	3.6	3.8	3.0	4.6	5.8	4.3
Average Age	45.6	40.1	41.2	43.3	45.5	46.7
% Male	74.0	60.0	41.2	80.8	82.0	44.3
%New	12.1	16.3	14.3	20.2	13.1	21.6
%Part Time	5.6	8.6	9.1	3.1	6.9	25.0
Number of Schools	15	298	23	8	30	22
% Up-To-18	73.3	52.7	65.2	100.0	80.0	86.4

1. Where the opposite sex is only admitted to the sixth form, this has been treated as a single sex school.

3.11 The average age of the physics teachers in the boys' maintained schools was similar to that of their independent counterparts. On the other hand, in the mixed comprehensive schools which have seen an influx of female teachers they tend to be younger. Independent girls' schools tended to have a high proportion of part-time teachers of physics, and both boys' and girls' independents to have made the most new appointments in 2004.

Resumé

3.12 Teachers with physics expertise are spread very unevenly across the schools and colleges so opportunities to engage with physics vary considerably. Grammar schools, up-to-18 independent schools, sixth form and further education colleges deployed as teachers of physics mainly teachers with degrees in physics or a closely related subject. Comprehensive schools, particularly the up-to-16 schools, tended to have a number of teachers contributing to the teaching of physical processes in science, few of whom have degrees in physics. This raises questions about the nature of the ladder through to the A-level courses in the sixth-form and further education colleges where there are generally well-qualified lecturers, but relatively few students.

3.13 Over half the physics teachers in the colleges were aged over 50, as were nearly 40 per cent of those in the grammars and up-to-18 independents. Teachers in the other schools tended to be younger but less well-qualified in physics indicating that as physics graduates leave they are being replaced in some schools by teachers with expertise elsewhere in science, often biology. They are also more likely to be female, but physics teachers remain predominantly male except in girls' schools.

4. Pupil Participation and Performance

4.1 We have seen that teachers of physics differ considerably in their level of qualification in physics and the extent to which they are deployed in teaching it. We have also seen that the best qualified teachers are clustered in particular types of institution. We inferred from this that the opportunities for a young person to engage in physics would depend very much on the path he or she took through the education system. The type of institution attended could also be expected to have a bearing on achievement in the subjects. In Chart 4.1 we map the distribution of the main courses including physics/physical processes across the system, and the pupils' performance in them. We have not included the International Baccalaureate because this was taken by too few institutions (only four in our sample) for the tabulation to be meaningful.

4.2 Nearly all the schools offered dual award science with its physical processes strand, though some independents and a few grammars offered the separate sciences exclusively. Comparing those schools which offered the dual award, we can see in Chart 4.1 that pupil performance varies widely, with over a third of the grammar and up-to-18 independent schools entrants being awarded A*/A compared with less than 15 per cent in the comprehensives and secondary moderns. When GCSE results are scaled from 8 for A* down to 1 for grade 'G', average performance in the grammars and independents is close to 'B', but that in the comprehensives and secondary moderns is around 'D'. The distribution is similar to that of the teachers with good qualifications in physics.

4.3 Although the dual award is apparently a common dimension on which we can compare schools, this is not, in fact, the case since, as Chart 4.1 shows, some schools make it possible for some of their pupils, usually their more able ones, to take the physics GCSE. The proportion of schools offering this opportunity ranges from 82.4 per cent of the independent up-to-18 schools down to 12.5 of the secondary moderns, with a big difference between the comprehensives up-to-16 (25.6 per cent) and those up to 18 (42.2 per cent). Children with similar potential for physics are likely to have very different opportunities according to the school to which they go. In all cases, pupils entered for the physics GCSE were more likely to achieve A*/A grades than the pupils taking the dual award, including the comprehensives, where the average grade attained in GCSE physics was just above 'C'.

4.4 Conversely, performance on the single award general science was generally much lower than for either the dual award or physics *per se,* suggesting that it was being used mainly as a fall-back for pupils with little aptitude or interest in science. In comprehensive schools the average grade was close to 'F'. Only in the grammar school was performance comparable with the other two examinations indicating perhaps that it was being taken by pupils with a strong inclination for other disciplines to free up time for those studies.

4.5 A-level physics was offered by all the grammar schools, up-to-18 independents and sixth-form colleges. Relatively few of the secondary modern schools had grown sixth forms, and not all FE colleges offered the subject. But in the case of the comprehensives to 18, 6.6 per cent of the schools offered other courses instead like applied science (leading formerly to a GNVQ, now the AVCE or vocational A-level). Again pupils' chances of finding out whether they like and/or are good at physics depend on the school attended.

Chart 4.1: Participation and Performance in Physics by School/College

Participation and Performance	Comprehensive to 16	Comprehensive to 18	Sec Mod	Gram	Independent to 16	Independent to 18	Sixth Form College	FE College
***Single Science GCSE*[1]**								
Number of Schools	61	89	12	2	5	12		-
%Schools	44.5	53.3	75.0	12.5	55.6	23.5		-
Entrants/School	31.1	32.0	36.1	17.0	5.6	6.2		-
Mean Score	2.3	2.5	2.4	5.9	3.7	4.3		-
Mean %A*/A	2.7	2.2	0.6	43.2	0.0	0.0		-
***Dual Science GCSE*[1]**								
Number of Schools	132	164	15	15	8	43	-	-
%Schools	98.5	97.6	100.0	93.8	72.7	84.3	-	-
Entrants/School	131.7	165.5	112.9	99.9	20.9	49.6	-	-
Mean Score	4.4	4.8	3.8	6.1	5.4	6.0	-	-
Mean %A*/A	9.9	14.7	4.7	36.8	20.1	34.5	-	-
***Physics GCSE*[1]**								
Number of Schools	28	60	2	10	2	40	-	-
%Schools	20.4	35.9	12.5	62.5	18.2	78.4	-	-
Entrants/School	20.2	35.0	30.5	56.6	6.0	30.4	-	-
Mean Score	5.0	5.2	5.4	5.9	6.5	6.4	-	-
Mean %A*/A	34.9	36.4	18.2	43.4	62.5	60.3	-	-
***AS Physics*[2]**								
N Institutions	-	144	5	14	-	49	11	17
%Institutions	-	86.2	31.3	87.5	-	96.1	100.0	68.0
Entrants/Institution	-	15.4	8.2	29.9	-	12.9	55.5	25.8
Mean Score	-	5.0	3.3	6.3	-	6.6	5.5	4.1
Mean %A Grade	-	19.1	4.2	26.0	-	35.2	21.5	10.3
***A-level Physics*[2]**								
N Institutions	-	156	5	16	-	50	11	16
%Institutions	-	93.4	31.3	100.0	-	98.0	100.0	64.0
Entrants/Institution	-	9.7	2.6	17.8	-	9.6	39.9	16.4
Mean Score	-	5.8	1.8	6.7	-	7.1	6.3	5.3
Mean %A Grade	-	22.3	0.0	26.6	-	36.1	23.6	10.9
Institutions in Sample[3]	137	167	16	16	9	51	11	25

1. Performance for GCSE results scaled from 8 for A* to 1 for G.
2. Performance for A-level and AS scaled 10 for A through to 2 for E.
3. Four up-to16 comprehensives did not provide examination results and 1 up-to-18 comprehensive did not provide GCSE results.

4.6 The largest numbers of A-level physics entrants are in the grammar schools and sixth form colleges (although here relative to the numbers studying other subjects it is low – Chart 4.2). The pattern of performance across the institutions is similar to the distribution of the well-qualified teachers. Over a third of the entrants from the up-to-18 independent schools obtained an 'A' grade, with the average scores in those schools and the grammars and sixth-form colleges being above 'C'. However, paradoxically, the FE colleges home to some of the best qualified physicists teaching 14-18 year-olds have a relatively low level of student performance. Entrants to the sector have fallen more sharply than elsewhere:

> "Recruitment of students to A-level physics has fallen from approx 200 in 1989 to approx 20 in 2004 – partly due to local political conditions. Two colleges merged. Between them in 1989 they had ten lecturers in physics, now there is only one, myself, plus a part-timer for the AVCE physics modules. A major problem is lack of colleagues to discuss issues on a day to day basis." (Male, Head of Science, FE College, East Midlands)

> "We have great difficulty in recruiting viable numbers for A-level physics. This is despite trying to combine courses with other centres. At the moment senior management are prepared to support the financial loss this incurs on the basis that we are providing a complete science provision." (Male, Curriculum Leader in Science and Maths, FE College, North East)

4.7 Comments in our survey from the heads of science in FE suggest that they are concerned by the lack of throughput to the subject from the 11-16 comprehensives.

> "The dwindling number of students taking up A-level physics is little to do with staffing at post-16, but a lot to do with teaching up to 16. All too often there are insufficient teachers at GCSE level, physics sometimes being taught by non-physicists as part of double science GCSE." (Male, Curriculum Leader in Physics, FE College, South West)

> "There is a general feeling that 'physics' at GCSE has been absorbed into double award science and is delivered by non-physicists in the local schools. As a result the more able 'scientists' are being influenced to study biology and chemistry rather than physics." (Male, Physics Lecturer, FE College, East Midlands).

4.8 Chart 4.1 also shows the AS results and, although we are comparing successive cohorts rather than the one longitudinally, it looks as though AS acts as a filter for A-level with, in all types of institution, more entrants but lower performance at AS than A-level. The Chart does not include information on the social background or the abilities of the intakes to the different types of institution.

4.9 We were able to get some glimpses of the social background of pupils in maintained schools from their eligibility for free school meals. We were also able to gauge the ability of the pupils across the institutions from published information on the pupils' performance at GCSE and A-level. These data are shown in Chart 4.2 along with the relative sizes of the school and numbers of students 16-18. The pattern of performance generally is similar to that we have described for physics, in particular indicating that institutions differ widely in the abilities of their intakes. Overall, pupils in the grammar schools and up-to18 independents did best and those in the secondary moderns and 11-16 comprehensives worst. The ability level of the entrants to FE colleges as judged by A-level results seems lower than that of the up-to-18 comprehensives, which is consistent with their poor showing in physics.

Chart 4.2: Intakes to Schools/Colleges

Highest Qualification in Physics	Comprehensive to 16	Comprehensive to 18	Sec Mod	Gram	Independent to 16	Independent to 18	Sixth Form College	FE College
Average Number on Roll	825	1,205	799	977	276	589	-	
Average Number 16-18	-	218	150	266	-	127	1,256	1,771
% Free School Meals	17.7	9.1	10.1	2.4	-		-	-
% 5 A*-C	50.3	61.4	41.2	97.1	75.2	90.9	-	-
A-L Pt Sc per Student[1]	-	264.2	167.6	353.9	-	334.7	291.4	200.0
A-level Pt Sc per Exam	-	75.8	59.9	87.2	-	92.2	77.6	68.7
Institutions in Sample	137	167	16	16	9	51	11	25

1. A-level points scores as published on the scale 120 for A through to 40 for E; elsewhere in the report the old scale of 10 to 2 is adopted since GCSE results are scaled in this way.

4.10 Eligibility for free schools meals is inversely related to performance across the institutions (with the secondary moderns somewhat out of line). Since physics performance is closely associated with general performance this suggest that pupils from less affluent homes have less opportunity to study physics and, therefore, are less likely to do well in it.

Resumé

4.11 Opportunity to study physics varies with background and the general ability level of the school. Pupils from low-income homes tend to be concentrated in those schools least likely to offer GCSE physics and with the least well-qualified teachers. Opportunities in FE appear to do little to rescue the situation. The largest numbers of the highest performing pupils come through the grammar schools. Pupils in independent schools do better, but there are proportionately fewer; the largest groups come through the sixth form colleges, but, on average, perform somewhat less well.

4.12 Pupil performance at GCSE and A-level varies across the institutions in parallel with teacher qualifications, with the exception of further education colleges which have well qualified but relatively low performing students. A number of schools, particularly the grammars and independents, enter pupils with the most aptitude for physics for the physics GCSE where the results are very good. In spite of some of the brighter students being entered for physics *per se,* pupils from the grammars and independents also did best on the dual award. The pattern is repeated at A-level with the sixth form colleges making a strong showing and comprehensives to 18 closing the gap. AS acts as a filter to A-level with the numbers appearing to drop quite sharply after AS (unless the 2004 AS are the first green shoots of a revival).

5. Teacher Qualifications and Pupil Outcomes

5.1 We have seen thus far that both the qualifications† of teachers of physics and the participation and performance of 14-18 pupils in physics vary widely across the schools and colleges. In this chapter we ask: is there a link between them?

Correlations

5.2 Simple bivariate correlation reveals that there is indeed an association between teacher qualifications in physics and both pupil participation and performance in the subject. Chart 5.1 shows that the opportunity to take physics as a separate science and the proportion of pupils in the 16-18 age range studying A-level physics are both significantly associated with the qualifications of the major teachers of physics, but interestingly not those of the minor teachers who contribute just a few lessons. The dual award science GCSE is the backbone of the array of science GCSEs and it is perhaps not surprising that opportunity to take it should be independent of teacher qualifications. However, Chart 5.1 also shows that success in it is correlated at a high level of statistical significance.

Chart 5.1: Teacher Qualifications and Pupil Outcomes

Pupil Participation and Performance in Physics	Correlations[1] with Level of Qualification of Teachers of Physics in Physics		
	Major[2]	Minor[3]	All
Participation			
% Dual Award Science GCSE (N=395)	-.032	-.003	-.078
% GCSE Physics (N=395)	.215**	.086	.268**
% Physics A-level (N=253)	.150*	.123	.134*
Performance			
GCSE Single Science (N=181)	.041	-.036	.124
GCSE Double Science (N=375)	.368**	.036	.357**
GCSE Physics (N=161)	.254**	.104	.307**
AS Physics (N=241)	.177**	.085	.171**
A-level Physics (N=259)	.363**	.056	.280**

1. Two stars indicates statistical significance beyond the 1 per cent level and one star beyond the 5 per cent level.
2. Teachers concentrating on the teaching of physics/physical processes.
3. Teachers identified by heads of department as teachers of physics, but who contributed only a few lessons. Some schools had mainly minor teachers with the physics teaching being shared across the science staff.

5.3 As well as the dual award, teacher qualifications are associated with results in GCSE physics, and AS and A-level physics. Again, the physics qualifications of the minor teachers appeared to have little bearing. Neither the qualifications of the major nor minor teachers were associated with pupil performance in the single award science.

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† When as shorthand we refer to teacher qualifications we are taking those in physics as a measure of expertise in physics. We are not implying that they are better teachers, beyond that to teach a subject you have to know something about it. Well-qualified in physics refers to the level of qualification attained, not the class of degree.

School/College Effects

5.4 But these are correlations and the link could be indirect. Both teachers and parents could be attracted to particular schools for different reasons so that the physics aspiring pupils and the teachers with most expertise in physics could just happen to be together in the same schools and colleges. In Chart 5.2 we bring together some of the data on teacher qualifications and pupil outcomes from Charts 3.7 (page 17) and 4.1 (page 20). We can see that across the school types there tends to be appreciable clustering, but in the further education sector, particularly the FE colleges, there are well-qualified lecturers but relatively few and poorly performing students.

Chart 5.2: Teacher Qualifications and Pupil Participation and Performance in Physics

Qualifications and Characteristics	Comprehensive[1] to 16	Comprehensive[1] to 18	Sec Mod	Gram	Independent to 16	Independent to 18	Sixth Form College	FE College
Teacher Qualifications[2]								
Major Teachers	5.6	6.7	5.1	7.0	5.3	7.0	7.7	7.7
Minor Teachers	3.7	3.7	2.7	6.2	4.1	5.4	4.8	5.0
Pupil Participation[3]								
% Dual Award Science	87.2	82.8	73.0	67.4	76.9	59.3		
%GCSE Physics	3.8	7.2	2.0	30.6	8.5	39.3		
%A-level		7.9	1.4	13.6		16.5	6.4	1.0
Pupil Performance[4]								
Single Science GCSE	2.3	2.5	2.4	5.9	3.7	4.3		
Double Science GCSE	4.4	4.8	3.8	6.1	5.4	6.0		
GCSE Physics	5.0	5.2	5.4	5.9	6.5	6.4		
A-level Physics		5.8	1.8	6.7		7.1	6.3	5.3

1.Although the results are here, and in other charts, presented by general type of institution, in scaling for multivariate analysis the school and college types were ordered by age range and achievement: 1= 11-16 comprehensive, 2= up-to-16 independent, 3=secondary modern (some now have sixth forms), 4= up-to-18 comprehensive, 5= grammar, 6= up-to-18 independent, 7=FE college, 8= sixth form college.

2. Scale created from the highest level of qualification in physics ranging from 10 for a PhD to 1 for a GCSE. Six and above indicates that the average level of qualification is at least a joint or combined honours degree in physics which we have adopted as our criterion for having a physics degree

3. Average percentage of year group entering the exams. The difference between GCSE dual award plus physics and 100 reflects the proportion studying single award and applied science and science GNVQs. These have not been included since they do not normally lead to A-level physics.

4. GCSE and A-level results scaled from 1 (grade G) to 8 (grade A*) in the case of GCSEs and 2 (grade E) to 10 (grade A) for A-level.

5.5 We can examine whether the apparent link between teacher qualifications and pupil outcomes is due solely to the mediating influence of school or college through partial correlation. In Chart 5.3 we look at the raw correlations of Chart 5.1 alongside those that are obtained when type of school/college is controlled for.

5.6 The link remains for pupil performance. Chart 5.3 shows that controlling for type of school/college reduces the association with both dual award and physics GCSE, but it nevertheless reaches statistical significance. In the case of A-levels, the correlation holds up very well, partly because the contrary effect of the further education colleges is removed. With the effects of school/college type removed, the analysis suggests that pupils tend to obtain better results at A-level when they have teachers with higher qualifications in physics.

5.7 Chart 5.3 also reveals an interesting pattern for pupil participation. The relationship at A-level remains when the effects of type of school/college are taken out. In other words, the better qualified the teachers are in physics, the more likely the pupils are to study physics at A-level. But whereas partialling out school type removes the association with GCSE physics, it reveals one for the dual award - where contrary correlations within school types appear to have masked the overall relationship. In grammar schools, for example, the correlation is negative probably because the schools with the more highly qualified teachers are more likely to offer GCSE physics, whereas for the secondary moderns it is positive since the dual award is the alternative to the single award, applied science and the science GNVQs.

Chart 5.3: Controlling for Institution

Pupil Participation and Performance in Physics	**Correlations[1] with Qualifications of Major Teachers of Physics** Raw[2]	Discounting Type of School/ College[3]
Participation		
% Dual Award Science (N=395)	-.032	.137*
% GCSE Physics (N=395)	.215**	-.011
% Physics A-level (N=253)	.150*	.140*
Performance		
GCSE Double Science (N=375)	.368**	.166*
GCSE Physics (N=161)	.254**	.178*
A-level Physics (N=259)	.363**	.300**

1. Two stars indicates statistical significance beyond the 1 per cent level and one star beyond the 5 per cent level.
2. Pearson product moment.
3. Partial correlation controlling for school/college type.

5.8 In the case of GCSE physics, the link between take-up and teacher qualifications appears to be entirely mediated by the school. The opportunity to take GCSE physics is provided by schools with teachers with good qualifications in physics. This sheds further light on the finding shown in Chart 4.1 (page 20) that whereas 78 per cent of the up-to-18 independents and 63 per cent of the grammars offered GCSE physics, only 13 per cent of the secondary moderns and 20 per cent of the up-to-16 comprehensives did so.

Chart 5.4: A-Level Take-Up and GCSE Physics

Award	**Take-up of A-level Physics[1]** Schools with GCSE Physics Entrants: N	Schools with GCSE Physics Entrants: %Physics	Schools without GCSE Physics Entrants: N	Schools without GCSE Physics Entrants: %Physics
Up-to 18 Comprehensive[2]	53	8.4	96	7.7
Grammar	10	16.7	6	8.4
Up-to 18 Independent	40	17.7	11	6.4

1. Average percentage by school of year group entered for A-level physics.
2. No information on sixth-form sizes of 18 Welsh schools so for them physics take-up could not be expressed as a percentage.

5.9 Another way of looking at the data is to compare schools entering pupils for GCSE physics with those not doing so in terms of the take-up of the subject at A-level. Chart 5.4 shows that, across the school types, those schools offering physics as a separate science at GCSE tended to have proportionally more taking the subject at A-level. There is a highly significant correlation between the proportions of pupils taking GCSE physics and A-level pupils taking physics (r=0.363**).

Common Threads

5.10 What is it about the type of school/college that makes a difference? We are able to gain some insights into this by factor analysing the data set to tease out the common threads underlying the pattern of results. The clearest picture shows up when we concentrate on the schools because, as we have seen, the further education sector is somewhat anomalous.

Participation

5.11 Chart 5.5 shows the rotated solution – which is designed to sharpen up differences – for physics take-up. Factor I which accounts for a fifth of the variation portrays the characteristics of schools in which physics is a popular A-level. They tend to be those schools with highly able pupils and teachers with physics expertise who concentrate on teaching physics.

Chart 5.5: Rotated Factors[1] in Physics Participation

Pupil Participation in Physics	**Varimax Rotated Component Matrix**					
	I	**II**	**III**	**IV**	**V**	**VI**
Type of School	.723	.364				
Boys', Mixed or Girls' School			.738			
%Pupils Eligible for Free School Meals	-.804					
%Pupils Achieving 5 Good GCSE	.789					
%Male			-.620	.374		
%Major	.517				-.654	
%New Members of Staff						.857
%Part Time			.639			
Number of Teachers of Physics				-.883		
Average Age				.531		-.386
Qualification Level of Major Teachers	.712				-.301	
Qualification Level of Minor Teachers					.819	
%Dual Award Science		-.938				
% Physics GCSE		.861				
% A-level Students Taking Physics	.533					.463
Per Cent Variance	20.1	12.7	9.8	9.4	9.3	8.2

1. Only loadings above 0.3 displayed.

I Physics Schools (Schools with relatively high proportions studying physics at A-level tend to be those with high ability pupils from advantaged backgrounds and teachers with good qualifications in physics who concentrate on teaching physics);

II GCSE Provision (The availability of GCSE physics depends on the type of school attended);

III Girls' Schools (Girls' schools tend to have fewer male and more part-time teachers of physics);

IV Male Teachers (Male teachers tend to be older and to be found where physics teaching is not spread around a lot of teachers);

V Teacher Deployment (The qualifications of minor teachers are higher and major teachers lower where schools mainly use minor teachers to teach physics);

VI Renewal (Take-up of A-level physics is also associated with schools making new appointments and having younger staff).

5.12 The other five factors, each accounting for around a tenth of the variation, draws out further strands. Factor II shows that the chance to study GCSE Physics depends on the type of school attended. Factors III and IV show how male and female teachers tend to be distributed across the schools. The qualifications of major and minor teachers load at opposite ends of Factor V which pulls out those schools which mainly share the physics teaching among minor teachers. This could be a matter of choice – 'science is the subject, not physics' – or it could be because they cannot get well-qualified teachers of physics *per se*. Factor VI, interestingly, is another factor on which A-level physics take-up loads and here it is associated with schools which are able to make new appointments with consequently a lower average age.

Performance

5.13 Chart 5.6 shows the rotated solution for physics performance running the results for dual award science, the physics GCSE and A-level physics instead of entry figures. Since the variables are otherwise the same, in many ways, the factor structure is similar to that for participation.

Chart 5.6: Rotated Factors[1] in Physics Performance

Pupil Participation in Physics	Varimax Rotated Component Matrix				
	I	II	III	IV	V
Type of School	.744				
Boys', Mixed or Girls' School		.736			
%Pupils Eligible for Free School Meals	-.765				
%Pupils Achieving 5 Good GCSE	.846				
%Male		-.666			
%Major	.435		-.713		
%New Members of Staff					.787
%Part Time		.576			
Number of Teachers of Physics				-.857	
Average Age					.692
Qualification Level of Major Teachers	.670		-.368		
Qualification Level of Minor Teachers			.802		
Dual Award Science Score	.759				
Physics GCSE Score	.407			.545	
A-level Physics Score	.595				
Per Cent Variance	24.4	9.9	9.6	9.4	8.8

1. Only loadings above 0.3 displayed.

I Good Results (Schools with good results in physics tend to be those with high ability pupils from advantaged backgrounds and teachers with good qualifications in physics who concentrate on teaching physics);

II Girls' Schools (Girls' schools tend to have fewer male and more part-time teachers of physics);

III Teacher Deployment (The qualifications of minor teachers are higher and major teachers lower where schools mainly use minor teachers to teach physics);

IV Physics vs Science (GCSE physics results tend to be better in those schools with fewer teachers of physics ie more concentrated teaching);

V Renewal (Schools making new appointments and having younger staff).

5.14 Factor I, accounting for nearly a quarter of the variance, shows that success in dual award science, the physics GCSE and A-level physics is most likely in those schools with high ability children and teachers well qualified in physics who are deployed mainly to teach physics. It is very similar to Factor I for participation which showed that these are also the schools most likely to offer physics as an A-level. Pupils attending 11-16 schools seem to be at a disadvantage in this respect.

5.15 Most of the other factors for performance were found also in the matrix for participation. The Girls' School factor comes out as Factor II, the Teacher Deployment factor as Factor III, and the Renewal factor as Factor V. The only new factor is IV which links results in GCSE physics with small physics departments. This is labelled as 'Physics vs Science' on the interpretation that GCSE physics results are most likely to be good where physics is taught by a few specialists rather than being spread around members of a large science department.

Explaining the Variation

5.16 While factor analysis can reveal underlying dimensions, it says nothing about the relative impact of the variables. We now take this up through regression analysis. Chart 5.7 summarizes the multiple regression on both participation and performance, and a clear pattern emerges which goes some way to answering the question with which we began this chapter.

5.17 Teachers' qualifications in physics do impact on pupil performance in GCSE and A-level physics. In both cases, it emerges as the second most important explanatory variable after pupil ability. At A-level where we can predict 31 per cent of variation between schools, five good GCSEs (taken as an indicator of pupil ability) accounts for 14.4 per cent and teacher qualifications 10.4 per cent. The other variable to come into play is school type which explains 5.4 per cent. In GCSE physics pupil ability and teacher qualifications together account for the 22.8 per cent of the variance explained.

5.18 In contrast, teacher qualifications in physics do not appear to be important in achievement in dual award science. Here nearly two-thirds of the variance is explained by the pupils' ability, with the better performance of girls' schools contributing a small additional amount.

Chart 5.7: Regressions on Participation and Performance

Physics	GCSE Double Science		GCSE Physics		A-level Physics	
Participation % Variance Explained[1]	12.7		26.7		32.5	
Main Contributions[2]	School Type	10.2	School Type	12.4	% Five Good GCSEs	12.2
	Younger Teachers	1.5	% Five Good GCSEs	11.9	School Type	7.0
	Girls' School	1.0			% GCSE Physics	4.1
					Boys' School	3.4
Performance % Variance Explained[1]	66.2		22.8		31.0	
Main Contributions[2]	% Five Good GCSEs	63.8	% Five Good GCSEs	14.4	% Five Good GCSEs	14.4
	Girls' School	1.3	Teachers' Qualifications in Physics	8.4	Teachers' Qualifications in Physics	10.4
					School Type	5.4

1. Multiple regression coefficient squared.

2. Variance partitioned by multiplying the beta weights by the product moment correlation with the dependent variable.

5.19 When it comes to participation pupil ability is again important, but school type has the greatest explanatory power. It determines whether GCSE physics and A-level physics are on offer, and the place of the dual award in the array of science GCSEs. Beyond school type little of the variation in dual award take-up could be predicted (since there is relatively little variation), although there are indications that it is more popular in girls' schools and the teachers tend to be younger since science teachers are easier to recruit than physics teachers. School type and pupil ability account for the explained variation between schools in GCSE physics participation. These two variables again account for most of the variation at A-level, but here participation in GCSE physics and boys' schools also come into play.

Resumé

5.20 Teacher qualifications and pupil performance in physics are correlated. In part, this is because the most highly qualified teachers and the best performing students are to be found in the same schools, but even with school or college controlled for, an effect shows through. Factor analysis reveals a common thread linking the take-up of A-level physics to pupil ability and background, school attended, and teachers with good qualifications in physics who mainly teach physics. A common thread also runs through the same variables and the results obtained in dual award science, as well as the physics GCSE and A-level physics.

5.21 Multiple regression on performance in the physics GCSE and A-level reveals that pupil ability and teacher qualifications account for most of the explained variance. Of the variables measured, pupil ability alone seems to predict success in the dual award science, with teacher qualifications in physics not featuring. School type along with pupil ability accounts for much of the explained variation in physics participation. Gender also shows through with pupils in girls' schools more likely to take and do well in dual award science, whilst pupils in boys' schools show the same trend in A-level physics. Taking GCSE physics seemed to bring proportionally more pupils through to A-level physics. Our analyses clearly show that teacher qualifications in physics do have a bearing on both pupil participation and performance in physics.

6. Views from Schools and Colleges

6.1 In the final section of the questionnaire we offered the schools and colleges an opportunity to comment on the situation as they saw it. We asked respondents, 'Are there any other comments you would like to add about the recruitment and deployment of teachers of physics in your school and/or generally?' The main themes to emerge were the difficulties of recruiting physics teachers in some – but not all - schools, the quality of those recruited, the age profile of the teachers, the lack of underpinning for A-level studies, differences in the conception of national curriculum science, and the impact on attracting and retaining students. We also report the comments of those schools and colleges where physics is thriving, and the suggestions that emerged for improving the situation where it is not.

Recruitment and Deployment of Teachers

6.2 Box 6.1 illustrates a cross section of replies. It is clear that many schools, both maintained and independent, are experiencing difficulties. But while there is evidence of general concern, some types of school in some locations are encountering more difficulty than the others. In particular, 11-16 schools seem to be at the sharp end since they cannot offer the opportunity to teach to A-level. As the curriculum team leader of an up-to-16 comprehensive put it, "Almost impossible to attract to a school which has no A-level physics to offer". The situation is exacerbated if the school is in special measures ("Can't get a physicist. We are not a particularly successful school and have been in special measures.") or is located in an expensive area ("Almost impossible to recruit a physicist to our school - nobody can afford to live on the salary here."). But even otherwise very successful schools are not immune. The head of physics in "a super school with excellent A-level opportunities" sadly reported "we find it very difficult to attract physics applicants."

6.3 In the face of the recruitment difficulties, schools, among other things, are having to:

- put a lot of effort into finding suitable staff ("4-5 rounds of advertisement/ interview");
- tailor the curriculum ("we have tried to structure the courses so that non-scientists can teach in an area where they have the necessary skills and expertise" – an English graduate with a sci-fi bug is cited as an example);
- recruit overseas ("current staff includes one teacher from South Africa and one from Sri Lanka");
- make do with supply cover ("an endless trail of supply teachers usually walk off with little or no course work achieved").

6.4 Not only is recruitment difficult, but physics teachers can often find that they are soon drawn away from the classroom:

> "One of our physics teachers was catapulted from second in science to assistant head after only two years in the job. This typically happens because they show an aptitude for figures and computer systems/timetabling etc. This person is no longer available to us for physics teaching." (Head of Science, Male, Community Comprehensive, Mixed, Up to 16, Yorks & Humb)

Box 6.1: Recruitment and Deployment of Teachers

'It has been extremely difficult to recruit a physics teacher over the past five years. Smaller schools in challenging circumstances in less popular areas, like this one, are all having the same problem.' (Head of Science - male)

Community, Comprehensive, Mixed, Up-to-16, North East

'We have no qualified physicists. We have trouble recruiting due to being in Special Measures.' (KS4 Co-ordinator and Head of Physics - female with chemistry degree)

Voluntary Aided, Comprehensive, Mixed, Up-to-18, Yorks & Humb

'Almost impossible to attract to a school which has no A-level physics to offer.'
(Curriculum Team Leader - male)

Community, Comprehensive, Mixed, Up-to-16, West Midlands

'Staff recruitment and retention is dire. I have been in post for four years and have never been fully staffed'. An endless trail of supply teachers usually walk off with little or no course work achieved.' (Head of Science - female)

Community, Comprehensive, Mixed, Up-to-16, West Midlands

'We find it very difficult to attract physics applicants despite the fact we are a super school with excellent A-level opportunities.' (Head of Physics - female)

Community, Comprehensive, Mixed, Up-to-18, Technology, Eastern

'We are a small school, about 500 on roll. We have tried to structure the courses so that non-specialists teach an area where they have the necessary skills and expertise. For example an English graduate is a sci-fi bug and has an interest in astrophysics so teaches the Earth, Space component.' (Science Co-ordinator - male)

Community, Comprehensive, Mixed, Up-to-16, Eastern

'The department did have a physics teacher prior to 2004/5 which gave balance and expertise in the department. Being an 11-16 school there isn't the progression into the sixth form that inspires some students.' (Head of Science - male)

Community, Comprehensive, Mixed, Up-to-16, Eastern

'*Increasingly difficult to recruit a teacher of physics, for us specifically and in Kent generally. The reasons include re-location expenses, house prices and salary levels*.' (Head of Science - male)

Voluntary Aided, Comprehensive, Mixed, Up-to-18, Languages, South East

'Can't get a physicist. I have not had a physicist since October 2000. We are not a particularly successful school and have been in special measures. We are starting A-level biology and chemistry Autumn 2005, but without a physicist (and no prospect of keeping one). How can I plan A-level physics?' (Head of Science and reluctantly a physics "expert" - female and a chemist)

Community, Comprehensive, Mixed, Up-to-18, Business & Enterprise, South West

'Almost impossible to recruit a physicist to our school (difficulty with its location in central London – nobody can afford to live on the salary here). If I leave, I am sure they could not find a replacement.' (Head of Physics - male)

Selective Independent, Day, Girls', Up-to-18, Inner London

'Have found the recruitment of quality enthusiastic, well-qualified physics specialist teachers extremely difficult (4–5 rounds of advertisement/interview). Current staff includes one teacher from South Africa and one from Sri Lanka.' (Head of Physics - male)

Selective Independent, Day and Boarding, Mixed, Up-to-18, South East

Box 6.2: Quality

'We have advertised fairly regularly in recent years for physics teachers and the numbers applying have been disappointingly low. In general, the quality of the candidates has been poor. Few have degrees in straight physics. More common seem to be degrees in astronomy, geophysics and engineering. With the shortage of physicists in teaching the consensus seems to be 'anyone can teach it' which in my opinion leads to further erosion of standards and less take-up.' (Head of Physics - female)

Voluntary Aided, Comprehensive, Mixed, Up-to-18, Languages, North West

'We have advertised for physics teachers three times in the last five years, but have appointed a biologist or a chemist because of the quality of the applicants.' (Head of Science - male)

Community Comprehensive, Mixed, Up-to-18, North East

'As I reach retirement, it riles me that the position of physics does not look very good. Most PGCE trainees available locally are biological science graduates with chemists and physicists forming a tiny minority.' (Head of Science - male)

Community Comprehensive, Mixed, Up-to-16, Yorks & Humb

'I have found that good physicists get so involved with their work they do not make good teachers in general. Of course there are good teachers who are physicists, but I haven't got any.' (Area Leader of Science - male)

VA, Comprehensive, Mixed, Up-to-16, Maths and Computing, West Midlands

'When physics graduates have applied they have been of low quality when seen teaching. As we teach science and all staff teach all sections/subjects then a good teacher is important – even over specialism.' (Head of Science - female)

Community Comprehensive, Mixed, Up-to-16, West Midlands

'Some supposed "physics" teachers come to us with great references but actually struggle to "teach". Just knowing the subject is not enough. The key is being able to communicate it to others. Experiences in year 9 tend to have a long term effect on attitude to the subject.' (Leader of Physics - female)

Community, Comprehensive, Mixed, Up-to-18, Maths & Computing, East

Where physical science posts are advertised there are very few applicants and the quality is just satisfactory. Presently we have a student who has a physics degree but is struggling in the teaching and classroom management requirements which are rather key areas!' (Head of Science/Physics - male)

Community, Comprehensive, Mixed, Up-to-16, Technology, South

'Inherently the subject attracts candidates at degree level who are less likely to make good teachers. This is unavoidable and incontrovertible. Trying to make the subject more "flash" is shallow and the not the answer.' (Head of Physics - male)

Selective Independent, Day, Mixed, Up-to-18, South West

'Finding good physics teachers is ridiculously difficult. We have tried three times in the last five years and chosen from poorly qualified and weak fields – thank goodness we found one eventually!' (Head of Science and Physics - male)

Selective Independent, Day, Mixed, Up-to-18, North West

'There has not been a full-time or qualified lecturer here since 2001. This was due to several appointees leaving after a short time. The physics department has suffered through low pass rates and poor attendance. Low take-up this year (8) does not bode well for physics at this college.' (Lecturer in Physics and Engineering - male)

FE College, North West

Quality

6.5 Difficulties in recruitment inevitably impinge on quality. As Box 6.2 illustrates, many of the schools reported having to appoint graduates from other disciplines as teachers of physics, because “finding good physics teachers is ridiculously difficult”. Quite often a biologist or chemist is appointed. “Most PGCE trainees available locally are biological science graduates.” The head of physics in a voluntary aided school in the North West fears that the shortage of physicists in teaching is being rationalised as “anyone can teach it” leading in her view “to further erosion of standards and less take-up”.

6.6 But physics background is not the only quality concern. With few applicants and little opportunity to choose, teaching ability can also be a problem. “Some supposed ‘physics’ teachers come to us with great references but actually struggle to ‘teach’. Just knowing the subject is not enough.” One of the heads of physics claims that it is “incontrovertible” that “inherently the subject attracts candidates at degree level who are less likely to make good teachers.” Another head of physics holds the same view, “good physicists get so involved with their work they do not make good teachers in general”. These are particular instances of our finding (Smithers and Hill, 1989) that the satisfactions of physics (impersonal abstraction) and teaching (people) are different making it especially difficult to attract teachers in the subject.

Age Profile

6.7 Recruitment difficulties in physics are exacerbated by the age profile of the teachers. Box 6.3 illustrates a cross-section of the comments. In Chart 2.7 (page 8) we showed that nearly a third of the teachers of physics who held physics degrees were aged over 50 while only 16.6 per cent were 30 and under. Not surprisingly, given the age distribution of the physics teachers displayed in Chart 3.4 (page 15) most of the concerns were expressed by the further education and sixth form colleges (53 and 52 per cent respectively over 50) and independent schools (39 per cent over 50).

6.8 Schools and colleges which have enjoyed great stability for a number of years are now finding that most or all of their physics staff are due to retire in the next few years, and are wondering if they are going to be able to replace them. The head of physics in an independent girls’ school in the South East neatly sums it up, “many teachers I know are coming up for retirement – where is the next generation?” There are always exceptions to test the rule. The head of science in an up-to-16 comprehensive reckons that low turnover is the problem, “career progression for a keen physics teachers is limited to filling dead man’s shoes here in the south west and we suffer from longevity!”

Underpinning for A-levels

6.9 With not enough well qualified teachers of physics to go round they tend to be deployed in teaching the exam classes. “This means”, according to the head of science in a grammar school in London (see Box 6.4), that “the key stage 3 classes may not get specialist teaching, causing poorer basic knowledge and enthusiasm. Therefore without an increase in teachers we can never increase uptake.” The head of physics in a comprehensive in Wales agrees, “A large proportion of physics at KS3 and 4 is taught by non-specialist teachers who admit to not having the knowledge base to do so.”

Box 6.3: Age Profile

'The age profile of the physics staff is also a concern. Of the four of us, the youngest is 48 and obviously we will all retire in the next 5-10 years.' (Head of Physics - male)
FE College, Wales.

'We have had two very experienced and excellent physics teachers retire in the last 18 months. Replacing them was very difficult. We had to interview for each post three times before finding anyone half suitable, yet we are a top college. Pay and conditions in the FE sector have fallen behind teachers' salaries, so it is difficult for us to compete.' (Head of Physics - male)
FE College, North West.

'Our staff have 150 years of physics teaching experience between them. The recruitment problem is about to hit us!' (Head of Physics - male)
Selective Independent, Day, Boys', Up-to-18, North West

'Many physics teachers I know are coming up for retirement - where is the next generation?' (Head of Physics - female)
Selective Independent, Day, Girls', Up-to-18, South East.

'It has been difficult to attract suitably qualified physics teachers. It is worrying that all five physics teachers here are about the same age and approaching retirement.' (Head of Physics - male)
Selective Independent, Day, Mixed, Up-to-18, North West

'Of the four physics teachers in the school, three have been at the school for over 19 years and the youngest for 10 years. We are going to lose one teacher next September and we may need to use one of the other science teachers to teach more physics.' (Head of Physics - male)
Selective Independent, Day, Mixed, Up-to-18, West Midlands

'We have had a very stable department for 25 years. But two of us are about to go and I fear we may not be able to recruit two capable physicists as replacements.' (Head of physics – female)
Community Comprehensive, Mixed, Up-to-18, Maths and Computing, North West

'Both physics teachers will retire within two years.' (Teacher i/c Physics - male)
Community, Comprehensive, Mixed, Up-to-18, Humanities, East

'One teacher is taking early retirement in July and another would like to if he could afford it. They are totally demoralised by pupil behaviour, the atmosphere of failure and lack of reward for working a 60-hour week.' (Head of Physics - male)
Voluntary Aided, Comprehensive, Mixed, Up-to-18, North West

'Both physics teachers are near retirement. It is very difficult to recruit physics specialists.' (Head of Science - male)
Voluntary Aided, Comprehensive, Mixed, Up-to-18, Combined Specialisms, South East

'We have just tried to replace a valued member of staff who is retiring. We were unable to appoint. Fourteen applied, most not English. They were all unsuitable for different reasons. The sole ITT student who applied had very shaky physics.' (Head of Physics - female)
Sixth Form College, East

'Career progression for a keen physics teacher is limited to filling dead man's shoes here in the south west and we suffer from longevity!' (Head of Science/Physics - male)
Community, Comprehensive, Mixed, Up-to-16, Technology, South West

Box 6.4: Lack of Underpinning for A-level

'The general lack of quality physics teachers means they get targeted at exam classes. This means that KS3 classes may not get specialist teaching causing poorer basic knowledge and enthusiasm. Therefore without an increase in teachers we can never increase uptake.' (Head of Science/Physics - male)

Foundation, Grammar, Boys', Up-to-18, Outer London

'A large proportion of physics at KS3 and 4 is taught by non-specialist teachers who admit to not having the knowledge base to do so.' (Head of Physics - female)

Community, Comprehensive, Mixed, Up-to-18, Wales

'Physics is always a problem as specialists have to teach GCSE – usually higher sets. Non-specialists teach KS3 and lower KS4 groups.' (Head of Physics - male)

Community, Comprehensive, Mixed, Up-to-18, Engineering, East Midlands

'Our new head of science is very keen to reduce the number of science teachers teaching each set at KS4. This means that next year more KS4 physics will be taught by teachers with a non-physics qualification.' (Head of Physics - male)

Community, Comprehensive, Mixed, Up-to-18, Arts, South West

We value the opportunity here for all teachers to teach outside their specialist areas. However the lack of physics specialist exposure to KS4 groups is serious. We have been unable to appoint a decent physics teacher for 3 years running.' (Teacher i/c Physics - female)

Voluntary Controlled, Comprehensive, Mixed, Up-to-18, Technology, Yorks & Humb

'*It is essential that dedicated enthusiastic physics teachers take all physics lessons from Year 8 at least. Non-specialists convey the impression the subject is difficult because of their own unfamiliarity and this instils prejudice and problems which can often not be rectified in pupils at a later stage.*'(Head of Science/Physics - male)

Selective Independent, Day and Boarding, Girls', Up-to-18, Yorks & Humb

'Teachers without a solid physics background struggle to excite and gain the confidence of the KS4 pupils. This is often manifest in behavioural issues. Interviewed candidates for physics posts have been very poor and many good candidates cannot afford to move to this area.' (Head of Physics - male)

Non-Selective Independent, Day and Boarding, Mixed, Up-to-18, South East

'Many of our students have not been taught physics at high school by a physics graduate and consequently the lack of thorough grounding in the subject makes A-level difficult for both students and staff.' (Head of Physics - male)

Sixth Form College, North West

'There is a general feeling that "physics" at GCSE has been absorbed into double award science and is delivered by non-physicists in the local schools. As a result more able "scientists" are being influenced to study biology and chemistry rather than physics.' (Physics Lecturer - male)

FE College, East Midlands

'I think that physics is taught in years 7-9 by teachers with inadequate knowledge, for example, PE teachers with science as a second subject (largely based on human biology) find themselves teaching say electrical circuits. This continues to a lesser extent at KS4.' (Subject Leader Physics - male)

FE College, South West

6.10 Physics is often seen as a hard subject by pupils. According to the head of science/physics in an independent girls' day and boarding school in Yorkshire and Humberside, this is attributable in part to non-specialist teaching lower down the school, "Non-specialists convey the impression the subject is difficult because of their own unfamiliarity and this instils prejudice and problems which can often not be rectified in pupils at a later stage."

6.11 The sixth form colleges and further education colleges are concerned that the teaching of physics (or rather the lack of it) in schools is impacting on their ability to recruit students. A physics lecturer in an FE College in the West Midlands puts its this way, "There is a general feeling that 'physics' at GCSE has been absorbed into double award science and is delivered by non-physicists in the local schools. As a result more able 'scientists' are being influenced to study biology and chemistry rather than physics." This is borne out by the statistics (Charts 3.2, 3.3, page 14), which show that 11-16 schools are the least likely to have teachers of physics with degrees in physics.

Physics or Science?

6.12 But the teaching of physics as science is not just a matter of the relative availability of physics and biology graduates as teachers of science. Since 'science' was made a compulsory subject for all pupils up to the age of 16 as part of the national curriculum, re-conceptualisation of what it is appropriate to teach and who is capable of teaching it has taken place. The view that 'science' is the subject is forcefully expressed in Box 6.5 by the head of science of an 11-16 comprehensive in the West Midlands, "Separate sciences are a totally artificial convenience. Science is one subject." He further asserts "all science staff should teach all science subjects to GCSE. Those that don't are lazy and have not developed professionally."

6.13 Other heads of department disagree. The head of physics at an up-to-16 comprehensive in the South West is despondent because "physics as an integrated subject has disappeared in this school." The head of physics in a girls' school in the Eastern Region says how much she hated having to teach chemistry this year and see her chemistry colleague attempt the physics. The head of physics in an independent school in Outer London argues, "biology and physics require totally different skills. Physics needs to be linked with maths rather than chemistry or biology". It seems that an ideological struggle is going on which could see physics disappearing as a subject in a number of schools.

6.14 Not all of the re-balancing is to do with teacher availability or ideology. A school in the North is abandoning the separate sciences because the LEA reckons it can deliver more A*/A grades on the dual award, and an independent schools believes it can improve its league table position through the combined science GCSE. Conversely, another school – maintained – is reintroducing the separate sciences, including physics, in response to parental pressure. While an independent in the East Midlands is going to run only the separate sciences allowing the pupils to drop one subject but not chemistry.

Box 6.5: Physics or Science

'*All science staff should teach all science subjects to GCSE. Those that don't are lazy and have not developed professionally as they should have done after the introduction of the national curriculum. Separate sciences are a totally artificial convenience. Science is one subject*.' (Head of Science - male)

Community, Comprehensive, Mixed, Up-to-16, Arts, West Midlands

'I am very despondent about the situation in physics teaching which I have previously taught to Oxbridge entrance level. With "balanced science" science being pushed, physics as an integrated subject has disappeared in this school. In the last ten years double science has been "dumbed down". Training for science teachers has actually deskilled staff.' (Head of Physics - male)

Community, Comprehensive, Mixed, Up-to-16, Sports, South West

'I have been asked to teach GCSE Double Science chemistry this year while chemistry specialists have been teaching physics. We have all hated it. My students did not do as well in their chemistry, needless to say I felt very insecure, particularly since I have not taught KS3 chemistry for a number of years. It is also very frustrating to see a chemistry specialist going off to teach a physics lesson they are not confident with either'. (Head of Physics - female)

Voluntary Aided, Comprehensive, Girls' Up-to-18, East

'Because of league tables we are being pushed into our top set (3 separate sciences done in double subject time) being changed to double award science. This is because according to the local authority our pupils are not getting the requisite A/A grades. The local sixth form college appreciate our single sciences and say we produce the best scientists from their feeder schools.'* (Head of Science - male)

Community, Comprehensive, Mixed, Up-to-16, Business and Enterprise, North West

'With mounting parental pressure we are having to re-introduce separate award physics.' (Head of Science - male)

Community, Comprehensive, Mixed, Up-to-16, Business and Enterprise, West Midlands

'Separate sciences are to be dropped this year. It is a decision of the head not of the department. One reason given is the difficulty of recruitment. None of our neighbouring schools offer the separate sciences.' (Head of Science - male)

Community Comprehensive, Mixed, Up-to-16, Technology, North East.

'We are under pressure to move to Combined Science "to improve results". The departments would prefer to keep the sciences separate – and to promote them as subjects in their own right. League tables have a lot to answer for!' (Head of Physics - male)

Selective Independent, Day and Boarding, Mixed, Up-to-18, South West

'Physics needs to be linked with maths rather than chemistry and biology. Double science has seriously damaged all the sciences. Biology and physics require totally different skills. Students often have specialist skills. They should not be required to continue with all sciences to 16. Breadth and balance has been a disaster.' (Head of Physics - male)

Selective Independent, Day, Boys', Up-to-18, Outer London

'Next year we are taking the (unpopular with me!) step of only offering GCSE separate sciences. Pupils are able to drop one subject – but chemistry is compulsory. Don't ask I don't see the logic myself.' (Head of Physics - male)

Selective Independent, Day, Girls', Up-to-18, East Midlands

Box 6.6: Attracting and Retaining Students

'The majority of our A-level and AS students are from overseas. In 2004 for A2 there was one English student, one German and 12 from China. In 2005 for A2 there are 2 German and 10 from China.' (Lecturer in Physics - female)

FE College, East Midlands

'We have great difficulty in recruiting viable numbers for A-level physics. This is despite trying to combine courses with other centres. At the moment senior management are prepared to support the financial loss on the basis we are providing a complete science provision.' (Curriculum Leader in Science and Maths - male)

FE College, North East

'Retention rates have fallen sharply – 60% for the current year. The number of hours allocated to each A2/AS group has been reduced from six hours pre-2000 to four and a half currently.' (Lecturer in Charge of Physics - female)

FE College, West Midlands

'Numbers are falling in physics. Physics staff are going into local schools to promote the subject. Numbers in chemistry and biology are ever increasing, possibly due to the prerequisites of medic/vet courses.' (Physics Co-ordinator - female)

FE College, Wales

'In our college we have a vast array of other subjects which are a) new and b) perceived to be easier than physics – hence they have a big take up eg psychology 168 at A2, communication studies 54 at A2, environmental science 28 etc. Most students look at the maths in physics and flee!' (Head of Physics - male)

Sixth Form College, West Midlands

'Student perception of physics as a "difficult" subject is the biggest issue. They often come to our college having received little tuition at GCSE level (quantity of physics in dual science and tutors available).' (Programme Co-ordinator - male)

Sixth Form College, North West

'Many of our intake studying science are interested in a medical career but few take physics. Most take chemistry, biology, maths and a broadening subject such as psychology. I have noticed that in the high schools in the NW London area the subject is taught at GCSE as science usually by non-specialists.' (Head of Physics - male)

Sixth Form College, Outer London

'We are a technology college with 75 pupils doing physics at GCSE, but although we are able to enthuse them, very few go on to do A-level. One of the main reasons is that the local sixth form college will only allow pupils to do AS physics with AS maths, not on its own.' (Head of Physics - male)

Community, Comprehensive, Up-to-16, Technology, Yorks & Humb

'Students are not choosing physics because they are looking at future careers and considering maximum return for the least effort. Physics is the most challenging subject – students are opting for something easier. Psychology is attracting many A-level students. Unlike other countries eg Germany/Japan the status of engineers/physicists is low' (Head of Physics - male)

Selective Independent, Day, Girls', Up-to-18, North West

'Students think that physics is one of the harder GCSEs/A-levels. In my girls' school there is still the perception that physics is a boys' subject, studied by bearded boffins in white coats in cold grey labs! Travesty! (Head of Physics - male)

Selective Independent, Day, Girls', Up-to-18, Outer London

Attracting and Retaining Students

6.15 Not only is it difficult to get physics teachers: it is also hard to attract students to A-level studies. Box 6.6 provides a cross-section of comments from the schools and colleges. FE Colleges especially are finding it difficult to attract sufficient students to continue offering A-level Physics. One in the East Midlands is running almost entirely on overseas students (mainly from Germany and China). Another is currently keeping physics going at a loss. A third seems to be suffering from poorer retention rates through cut-backs in course time. The FE Colleges are suffering particularly, but the decline in interest in A-level physics seems general.

6.16 The heads of department put forward a number of reasons:

- competition from other subjects ("in our college we have a vast array of other subjects which are a) new and b) perceived to be easier");
- physics perceived as difficult ("they often come to our college having received little tuition at GCSE level – quantity of physics in dual science and tutors available.");
- no longer required for entry to medical schools ("numbers in chemistry and biology are ever increasing, possibly due to the prerequisites of medic/vet courses");
- lack of fit between 11-16 and A-level courses ("the local sixth form college will only allow pupils to do AS physics with AS maths, not on its own");
- career prospects ("students are not choosing physics because they are looking at future careers – the status of engineers/physicists is low");
- stereotypes ("in my girls' school there is still the perception that physics is a boys' subject").

6.17 All of these may well contribute, to a great or lesser extent, to the decline of physics at A-level, but as we have also seen in Chapter 5 the availability of courses and well-qualified teachers have a major part to play. The type of school/college also has an important bearing.

Physics Thriving

6.18 Physics is not declining in all schools and colleges. Some notably buck the trend. The school - a girls' school in the Eastern Region - with which we begin Box 6.7 wonders why "nobody appears interested in our success story. We have tried to share good practice". A sixth form college in the North West reports that the number of physics students is increasing and an extra appointment has been made. A number of the maintained schools say they are "lucky" or "fortunate" to have secured a good balance in their science departments with physics well represented.

Box 6.7: Physics is Thriving

'We are a girls' school with a highly successful physics department both in terms of uptake and outcomes, yet nobody appears interested in our success story. We have tried to share practice/become a centre of excellence.' (Deputy Head - male)

Foundation, Grammar, Girls', Up-to-18, Technology, East

'We feel very lucky to have an exceptional physics department with a balance of experience and highly motivated staff. Having five specialist physics teachers in a team of 14 science staff is a good ratio!' (Head of Science – male)

Community, Comprehensive, Mixed, Up-to-16, North West

'The number of physics students is increasing in our college. We have employed an extra physics teacher who is due to start in September.'(Head of Science and Maths - male)

Sixth Form College, North West

'We are fortunate in that we have three physics specialists teaching physics throughout the school. I believe this has had considerable impact on the numbers opting to study physics in the sixth form.' (Head of Science/Physics - male)

Voluntary Aided, Grammar, Boys', Up-to-18, Languages, West Midlands

'Our school is lucky to have a wealth of physics teachers and a high status department that attracts large numbers post-16.' (Head of Science - female)

Community, Comprehensive, Mixed, Up-to-18, Science, West Midlands

'We do not have a problem recruiting physics teachers. We have an excellent teacher training institution nearby and have always managed to appoint suitably qualified staff.' (Head of Physics - female)

Community, Comprehensive, Mixed, Up-to-18, Languages, East

'We have five well-qualified physicists on the staff and are well catered for.' (Head of Science - male)

Community, Comprehensive, Mixed, Up-to-18, East

'I think our commitment to GCSE physics and Advancing Physics helps to maintain the integrity of the department. This in turn helps our take-up. We are able to recruit and retain physics graduates and are fortunate in that.' (Head of Science - male)

Selective Independent, Day and Boarding, Mixed, Up-to-18, South West

'We are lucky in that we are a well-regarded department in the school. None of the physics teachers is a "weak link". Numbers studying the sciences are high.' (Head of Science - male)

Selective Independent, Day and Boarding, Mixed, Up-to-18, South East

'We have had no difficulty in recruiting well-qualified and committed staff to teach physics. We have small class sizes, few discipline problems and a good budget for equipment and good technician support. This makes the job of teaching much easier.' (Head of Physics - female)

Selective Independent, Day and Boarding, Girls', Up-to-18, South East

'We're fortunate that physics is all taught by specialists and, in general, we've been able to attract a good field of applicants during recruitment. A generous timetable allows teachers time for enrichment activities.' (Head of Physics - male)

Selective Independent, Day, Girls', Up-to-18, Inner London

Box 6.8: Possible Ways to Improve the Situation?

'Better pay and facilities to attract physicists into teaching.' (Teacher of Physics - male)

Community, Grammar, Boys', Up-to-18, Science, Outer London

'Physics graduates are few in number and in demand. Teaching will not attract its share of these unless salaries can match those attracting elsewhere. Teaching practical subjects in laboratories is demanding – differentials are required. Not just to induce people in, but to keep them there.' (Head of Science - male)

Selective Independent, Day, Boys', Up-to-18, East Midlands

'Part of the solution is to pay more realistic salaries to attract high quality, enthusiastic and motivated staff.' Head of Physics - male)

Selective Independent, Day and Boarding, Girls', Up-to-18, East Midlands

'A recent IoP magazine to schools quoted salaries for physicists involved in research which were lower than my salary as an experienced HoD. May be this fact should be made more obvious to physics graduates.' (Head of Science - male)

Community, Comprehensive, Mixed, Up-to-16, Technology, Outer London

'The behaviour of pupils and the lack of status makes teaching unattractive. These need to be tackled.' (Head of physics – female)

Community, Comprehensive, Mixed, Up-to-18, East Midlands

'Better technician support.' (Head of Science - male)

Voluntary Aided, Comprehensive, Mixed, Up-to-18, Technology, North East

'A three-month sabbatical every five years needs serious consideration.' (Head of Physics - male)

Community, Comprehensive, Mixed, Up-to-18, South West

'Physics teachers do not like teaching chemistry and biology. They are much more comfortable with maths. Most would prefer to be physics/maths teachers.' (Head of Physics - male)

Voluntary Aided, Comprehensive, Mixed, Up-to-18, North East

'If they dropped the ridiculous requirement that physicists have to do chemistry and biology to get on a PGCE we might recruit physics graduates, many of whom can teach maths, but do not have any affinity with biology or chemistry.'(Head - male)

Selective Independent, Day and Boarding, Girls', Up-to-18, South West

'The PGCE in science is hopeless! Scrap it, or supplement it with a PGCE in physics and maths. That way teachers get to teach what they are good at!'(Head of Physics - male)

Selective Independent, Day and Boarding, Mixed, Up-to-18, East

'Our move to Advancing Physics has had a positive effect on take-up, but it places a much greater burden on staff – much more course work to mark/greater lesson preparation time required.' (Head of Physics - male)

Selective Independent, Day and Boarding, Mixed, Up-to-18, South West

'If the medical schools asked for A-level physics the numbers studying the subject would increase dramatically. A large number of our A-level chemists are "would-be doctors". ' (Head of Physics - female)

Sixth Form College, Inner London

6.19 Some schools hint how they have managed to achieve good physics staffing. A maintained school has an excellent teacher training institution nearby. An independent school in the South West thinks that GCSE Physics and Advancing Physics "help to maintain the integrity of the department" which promotes take up by students and attracts well-qualified physics teachers. Another independent school "has small classes, few discipline problems and a good budget for equipment and technician support". A third independent school draws attention to its "generous timetable (which) allows time for enrichment activities".

6.20 The statistical analysis of Chapter 5, and indeed throughout this report, has shown the role of school or college to be crucial. In some - but not many - schools and colleges physics is buoyant. We should seek to discover what they are doing, and what can be distilled and passed on to others.

Ways to Improve Physics Teacher Recruitment

6.21 The thoughts of the heads of department had already turned to possible ways in which more good physics graduates could be brought into teaching and also how student take-up could be increased. Their views are summarized in Box 6.8. The suggestions for attracting teachers ranged from more money to better definition of the subject:

- more money ("better pay and facilities" especially since "physics graduates are few in number and in demand", though there is some evidence that teachers salaries are now better than research salaries);
- tackling poor pupil behaviour and lack of status of teachers;
- better technician support;
- sabbaticals;
- recognising the affinity between physics and maths ("Physics teachers do not like teaching chemistry and biology. They are much more comfortable with maths." And "Scrap the PGCE in science, or supplement it with a PGCE in physics and maths").

6.22 Among the ideas put forward for attracting more students were:

- Improving the curriculum ("Our move to 'Advancing Physics' has had a positive effect on take-up");
- Making it once again a requirement for medical schools!

Resumé

6.23 The concern of the heads of department about the current state of physics in schools and colleges was reflected in the large number who took up the invitation to comment. Six main themes emerged: the difficulties experienced by many schools, particularly those in unfavourable circumstances, in recruiting physics graduates as teachers of physics; the impact these difficulties are having on quality; the looming wave of retirements; the deployment of the physics graduates available to teaching exam classes leaving the underpinning in the hands of non-physicists; the ideological struggle over whether physics is properly regarded as a separate subject; and the difficulty of attracting students.

6.24 A number of suggestions were made for improving the recruitment of physics graduates to teaching, ranging from more money to restructuring the training courses. Not all schools and colleges were experiencing a decline in physics. In some, by their own report, it was thriving. It is suggested that these schools and colleges should be studied to see what lessons can be learned from them.

7. Physics Teacher Supply and Requirement

7.1 The shortfall in the training of physics teachers is widely acknowledged, but recently the government has been optimistically suggesting that a corner has been turned.

Current Supply of New Physics Teachers

7.2 Certainly comparisons with the year 2000, as in Charts 7.1 and 7.2, look promising. These give applications and acceptances to PGCE courses in science and the separate sciences. Both applications and acceptances to the specialist physics PGCE courses are up substantially – 58.9 per cent for applications and 56.4 per cent for acceptances.

Chart 7.1: Applicants[1] to PGCE Science Courses by Year

Science	2000	2001	2002	2003	2004
Chemistry	668	768	795	742	828
Physics	343	372	455	511	545
Biology	1,609	1,790	1,698	1,625	1612
Combined/General	1,067	1,115	1,091	1,210	1362
Other	41	48	40	40	33

1. England and Wales.

Source: GTTR Applicant Statistics posted on website at www.gttr.ac.uk.

Chart 7.2: Accepted Applicants[1,2] to PGCE Science Courses by Year

Science	2000	2001	2002	2003	2004
Chemistry	403	443	481	494	485
Physics	218	226	278	352	341
Biology	903	919	965	986	917
Combined/General	696	689	716	848	913
Other	17	15	18	20	17

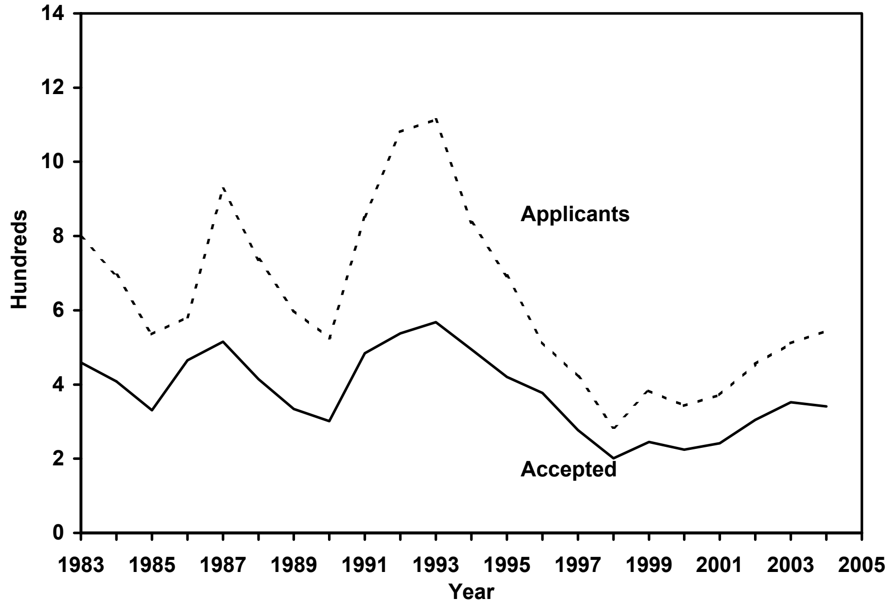
1. England and Wales.
2. Based on funded places and including deferred entry.

Source: GTTR Applicant Statistics posted on website at www.gttr.ac.uk.

7.3 But, while the increases are welcome taking a longer view, as in Chart 7.3, puts them in perspective. What is now seen as a recovery is, in fact, below what was regarded as a crisis in 1985. The somewhat bumpy nature of the curve reflects both a previous attempt to rectify the situation and the impact of economic trends. Following growing alarm about shortage of trainee physics, the Conservative government in 1986 introduced a bursary scheme which for a period boosted applications. Applications rose more quickly than admissions, suggesting that not all those who were drawn to put themselves forward were suitable. The effects of the bursary scheme faded, but were soon overtaken by the economic recession of the early nineties which led more graduates, including physicists, to consider teaching. As the economy picked up again, interest in teaching waned and recruitment to physics PGCE courses fell to its lowest point ever in 1998. It is from that nadir we are seeing some recovery.

7.4 This has been encouraged by a programme of incentives devised by recent Labour governments. These have been successful to the extent that more graduates are now being attracted to train as physics teachers against the background of a thriving economy. But because the subject in the national curriculum is labelled as science the incentives apply as much to biologists as physicists and chemists, and traditionally there has been little difficulty in recruiting graduates from the biological sciences.

Chart 7.3: Recruitment to Physics PGCE Courses



7.5 We can see in Chart 7.4 the effects of the redefinition of the sciences as 'science' and the greater availability of graduates from one discipline - biology - as teachers.

Chart 7.4: Subject Balance in PGCE Intakes[1] in the Sciences

Year[2]	N	Per Cent				
		Chemistry	Physics	Biology	Combined/ General	Other
1983	1,529	30.1	30.0	28.6	5.4	5.9
1986	1,377	25.1	33.8	32.1	4.4	4.6
1989	1,375	30.5	24.3	37.6	3.7	3.9
1992	1,972	25.6	27.3	34.4	7.7	5.0
1995	2,519	21.0	16.7	31.4	25.8	5.2
1998	2,028	18.2	9.9	40.2	30.1	1.5
2000	2,271	17.2	9.9	39.9	32.7	0.8
2001	2,360	19.3	10.3	38.2	31.5	0.7
2002	2,458	19.6	11.3	39.3	29.1	0.7
2003	2,700	18.3	13.0	36.5	31.7	0.7
2004	2,673	18.1	12.8	34.3	34.2	0.6

1. England and Wales.

2. 1990-92 does not include articled teachers.

Source: *GTTR Annual Reports* for 2003 to 2001. From 2002 data taken from GTTR website since from then the Annual reports include Scotland.

7.6 In 1983, when data were first collected in this form, the PGCE intake to the sciences comprised the three main disciplines in similar proportions. But, as Chart 7.4 shows, physics' share has fallen to only about one-eighth. Chemistry's relative contribution has declined also. In contrast, biology has grown. This makes it easy to understand why in our survey it is the older teachers who are the most qualified in physics and why much of the Key Stage 4 science teaching, and, by extension, the Key Stage 3 teaching, is undertaken by biologists.

7.7 There has also been a growth in combined sciences courses reflecting the national curriculum definition of the subjects as 'science'. But as we can see from the cross-tabulation of subject of degree and subject of teacher training in Chart 7.5, biologists are in the great majority here also. The statistic that stands out, however, is how few of the physics graduates wanting to become teachers actually train to be teachers of physics itself – in the year studied only 80 out of 187 (42.8 per cent). The remainder of the intake was made up mainly of engineers and technologists with a scattering across other subject areas.

Chart 7.5 Degree Subjects of PGCE Trainees[1], 2001-02

Degree Subject	PGCE Course					Total
	Physics	Chemistry	Biology	Comb/ General	Maths	
Chemistry	1	177	14	128	9	329
Biochemistry/ Biophysics	-	38	37	92	3	170
Physics	80	2	3	55	47	187
Biological Sciences	2	9	314	396	9	730
Medical Sciences	2	9	64	89	4	168
Other Sciences	6	14	11	80	33	144
Combined Science	8	13	21	98	21	161
Mathematics	0	0	0	2	566	568
Engineering & Technology	31	10	13	44	187	285
Other Subjects	4	5	17	51	190	267
Total	134	277	494	1,035	1,069	3,009

1. Numbers do not tally with those of Chart 7.2 since: Chart 7.2 includes Wales; it gives accepted applicants whereas 7.5 refers to successful completers; there are differences in classification with more trainees assigned to general or combined science in 7.5; and PGCE trainees through school-centred schemes (SCITTs) are not included in 7.5.

Source: Teacher Training Agency (personal communication).

7.8 While 55 of the other physics graduates were taking combined science PGCEs, 47 or 25.1 per cent had opted to teach maths. The reasons for this should be investigated, particularly if in order to increase the supply of maths teachers further incentives are to be offered in this subject. But, at all events, we have a paradox: when there is an acute shortage of physics graduates teaching physics, more than a quarter of those entering teaching are choosing not to teach physics itself, but maths instead. We saw evidence of this also in schools where ten per cent of the physics graduates were not teaching physics at all. In training, as in the schools, the gap is filled largely by biologists whose PGCE intake is about three times that of the physicists, with a preponderance also of biologists on the combined courses.

Physics Teacher Requirements

7.9 With physics not being clearly defined in the national curriculum and with schools differing in the view of who is qualified to teach the subject, it is difficult to calculate from first principles the actual requirement for physics teachers, but it is possible to ask whether current teacher availability is sufficient to at least maintain the status quo.

Inflows and Outflows of Physics Teachers

7.10 Our survey enables us to make some reasonable estimations of the inflow and outflow of physics teachers in the school year 2004-05. At the time of the survey in February 2005 we found 18,230 teachers of physics to 14-18 year-olds across schools and colleges of England and Wales, with 7,960 having teaching physics/physical processes as their principal task (Chart 2.1, page 5). Among these 'major' teachers, 970 were new appointments in 2004-05, some moving from other schools, some newly-trained and some coming back into teaching. The subject background of these new appointments is given in Chart 7.6. From the subject qualifications of existing staff we can infer what those of the leavers would have been, and these are also shown in Chart 7.6 for comparison.

Chart 7.6: Inflows and Outflows of Physics Teachers[1]

Subject Qualification	New Appoints	Leavers[2]	Gain /Loss
Physics	630	650	-20
Biology	130	90	+40
Engineering/Technology	90	100	-10
Chemistry/Physical Science	50	80	-30
Maths	10	10	no change
Other	60	50	+10
Total	970	970	0

1. All major teachers – full-time 91.6 per cent of leavers and 91.3 per cent of new appointments
2. Estimated from the pattern of qualifications among teachers already in the schools and colleges.

7.11 It would be wrong to read too much into the estimates of Chart 7.6, but they do indicate that the current availability of physics teachers is at best only just enough to sustain the present situation. Since this has arisen from continuing shortfalls it is, in itself, unsatisfactory. If anything the figures of Chart 7.6 suggest that fewer of the new appointments have physics expertise, and gaps are increasingly being covered by biologists, geographers and others rather than by engineers and physical scientists. The general pattern accords with the personal experiences of those recruiting in schools and colleges, a selection of whose comments were presented in Chart 6.1 (page 32).

Availability of Physics Teachers

7.12 If 970 was the requirement for teachers with teaching physics/physical processes as their principal task in 2004-05, we can see in Chart 7.7 how this is likely to have been met. We can make estimates based on reasonable assumptions of the number of (1) teachers moving between schools; (2) PGCE completers taking up school posts; (3) trainees from employment-based routes (Graduate Teacher Programme, Registered Teacher Programme, Overseas Trained Teacher Programme and Teach First); and (4) returning teachers or those making deferred entry. Chart 7.7 shows that when these are added together the total falls about 25 short of the estimated requirement. This is consistent with the finding in Chart 7.6 that rather more of the entrants than the leavers were qualified in subjects other than physics, particularly biology.

Chart 7.7: Physics Teacher Supply

Subject Qualification	Basis	Estimate
Moves Between Schools	40% of Leavers[1]	390
PGCE Completers	Acceptances less 20%[2]	280
Employment Based Routes	25% of 660[3]	165
Re-entrants	Equivalent to 40% of NQTs[4]	110
Total		945

1. Smithers and Robinson (2005) found moves between schools accounted for about 40 per cent of the resignations of male secondary teachers in 2004.

2. Reduction by 20% allows for 10% dropout and failure on courses, and 10% non-entry into teaching. This is a conservative estimate. Smithers and Robinson (2001) found losses of 40% in the late 1990s, but some will have been to independent schools and the FE sector included here, and 'golden hello's' could have been expected to have reduced losses among completers.

3. Employment based routes into teaching in the sciences is not currently disaggregated into the separate disciplines. *Statistics of Education School Workforce in England 2004 Edition,* Table 2, gives 660 as the number of science EBRs in 2003-04.

4. *Statistics of Education School Workforce in England 2004 Edition,* Table 12a (i) shows re-entrants and entrants new to the maintained sector are equivalent to about 40 per cent of the newly qualified entrants.

7.13 Putting Charts 7.6 and 7.7 together suggests teacher training supply in physics is barely keeping pace with maintaining present levels of provision and there are reasons for believing the situation will become even more challenging. The age profile of physics teachers indicates their rate of departure will be increasing in the coming years. Of the 7,960 major teachers of physics, 2,450 were aged over 50. thus nearly a third (31 per cent) will have to be replaced in the next ten years. Only 1,320 of the major teachers were aged 30 or under.

Schools Without Any Physics Teachers

7.14 Difficulties in recruiting physics teachers have left their mark. Already some schools are without any teachers who have studied physics to any level at university. In our survey 45 of the ten per cent sample of schools and colleges were in this position, not including the seven FE colleges (28 per cent) who had no students. Most of the schools without physics expertise were 11-16 schools where nearly a quarter (23.5 per cent) had no one who had themselves studied the subject above A-level or even GCSE level. Seven of the 11-18 comprehensives (4.2 per cent) also had no physicists.

7.15 A further 52 schools had only a quarter or fewer of their teachers of physics who had experienced the subject at university. When added to those without any at all, we find that 23 per cent of the schools and colleges teaching physical processes/physics to 14-18 year-olds in England and Wales have at best a quarter or fewer of their teachers of physics with some university experience in the subject. This includes 40 per cent of the 11-16 comprehensives, 17.5 per cent of the 11-18 comprehensives and 56.0 per cent of the secondary moderns. In contrast, none of the grammars, sixth form colleges or FE colleges, and hardly any independents, were in this predicament.

Projections

7.16 Scaling up from the sample suggests that 450 schools have no one with university experience in physics. In order that every school should have the opportunity, within say five years, of appointing at least one teacher with a good understanding of physics, present levels of physics teacher training would need to be increased by 90 a year. If, as seems reasonable, a school should be able to appoint at least two, then this would imply the training capacity should be increased by 180.

7.17 If we further say that the additional 520 schools with a quarter or fewer of their teachers of physics with no more than school-level physics themselves should have the opportunity of appointing at least another teacher well-qualified in the subject, then this would mean increasing the training capacity by another 104 per year. Rounding and recognising that loss through retirement is increasing suggests that with the 180 already estimated an extra 300 teachers with good qualifications in physics are required each year.

7.18 If we take present training output as about 450 (PGCE and EBR from chart 7.7) which itself does not quite maintain present levels of staffing and add the 300 arrived at, it looks at though the aim over five years should be to raise the output of newly-trained teachers in physics to something around 750 a year. This would be nearly 200 above that reached in 1993, the peak year for recruitment (see Chart 7.3). It is doubtful whether this is achievable by carrying forward present arrangements.

7.19 A quarter of the physics graduates training to be teachers, however, opt to specialise in maths and it is possible that some restructuring of PGCE courses along the lines suggested in Box 6.8, page 42 would bring in more trainees. Chart 7.7 indicates that the employment-based routes are already an important source of physics teachers and the number of places should be increased. There are currently plans to extend beyond London the Teach First initiative whereby graduates intending to make their careers in business or industry teach for two years, with some deciding to become teachers. Gatsby Technical Education Projects is working with the Training and Development Agency for Schools to increase the number of specialist physics teachers by recruiting people with insufficient physics in their backgrounds and topping this up before, during and after the PGCE. It is in its second year of piloting with an entry of 40 and the government has agreed a target for 2006 and beyond of 200. The kind of increase which our calculations show is required is, therefore, not beyond the bounds of possibility.

Resumé

7.20 Recruitment to physics PGCE courses has improved in response to government incentives, but it is still below the level which was regarded as a crisis in the 1980s. The vacuum has been filled largely by biologists, aided by the redefinition of the sciences to ‘science’. Not all physics graduates training to teach do so to teach physics – a quarter train as maths teachers.

7.21 Analysis shows that current levels of training output are barely sufficient to maintain the *status quo*, which itself is unsatisfactory. Nearly a quarter of 11-16 schools and 450 schools overall have no teachers who have studied physics at any level at university and this rises to 40 per cent if we take into account those with a quarter or fewer. More than one in six (17.5 per cent) of the up-to-18 comprehensives are in this predicament also. It is suggested that training capacity needs to be raised over five years from about 450 to 750 to meet these shortfalls. In order to reach this level some restructuring of PGCE courses may have to take place and a further increase in places on employment-based routes will be required.

8. Issues

8.1 Physics is in danger of disappearing as an identifiable subject in many schools, particularly 11-16 schools. This has come about partly by ‘science’ being the subject category used in the national curriculum and partly through the difficulty of attracting sufficient physics graduates into teaching.

8.2 ‘Science’ was originally adopted as the national curriculum subject because to have made physics, chemistry and biology compulsory in their own right to age 16 would have taken up too much of the curriculum time available. This was bolstered by a belief among some educationists that science is science and division into separate sciences was artificial and gender-biased. The hope was that with all pupils continuing in science to age 16, there would be an appreciable increase in the take-up of the A-level sciences. While this has been true for biology, the graph with which we began this report (Chart 1.1, page 1) shows that far from becoming a springboard for physics since the national curriculum and science GCSEs were introduced, the take-up of the subject at A-level has progressively fallen.

8.3 The reasons remain to be fully investigated, but a hypothesis worth testing is that physics is no longer sufficiently identifiable pre-16 for pupils to become clear about whether they like it and are good enough at it to take the risk of making what they have been told is a difficult subject one of their A-level choices. Comments from the sixth-form colleges, and particularly the FE colleges where the take-up of A-level physics is declining more sharply than elsewhere, indicate a widespread belief that the underpinning for physics in their feeder 11-16 schools is insufficient for students to have the confidence to take physics at A-level (Box 6.4, page 36).

8.4 The decline could, however, be due to something quite different. As the comments of Boxes 6.6 and 6.8 (pages 39 and 42) indicate, physics is no longer a requirement for medical schools, which may have inflated take-up in the past. On the other hand, our analysis has shown there is a greater flow through to A-levels from the schools offering the physics GCSE. But again this could be because they are the schools with the more able pupils which have been able to attract the teachers with the better qualifications in physics by offering the opportunity for them to specialise.

8.5 Whatever the reason(s) the apparent hiatus between science to age 16 and the physics A-level (and in turn university applicants) is a cause for concern. An issue which needs to be fully aired and investigated is:

Should physics be more clearly identifiable as a school subject pre-16 and, if so, in what form?

8.6 The integration of the sciences into “science” is likely to proceed further following the change in the Qualifications and Curriculum Authority’s specifications for GCSE science from September 2006. This will see double award science as offered by the Oxford, Cambridge and RSA Examinations Board (OCR, 2005) replaced by a single GCSE Core Science plus either an Additional Applied Science GCSE or Additional General Science GCSE. The intention is that these GCSEs should both provide a basis for pupils to be able to make sense of the science they come across in their everyday lives and also a route through for future scientists and engineers. But within the GCSE Core Science there is very little physics and it is not identified as such. The Additional General Science does include 'explaining motion', 'electrical circuits' and 'the wave motion of radiation' alongside such topics as 'homeostasis' and 'chemical patterns', but again there would seem to be little opportunity to develop a physics identity. A GCSE in physics (and chemistry and biology) will continue to be offered alongside the integrated science GCSEs and it becomes an issue for the professional bodies what advice they should give to schools about providing routes for future scientists through to A-levels and on to university.

Should the science community review the relative merits of the separate sciences and integrated science at GCSE as a basis for educating the physicists of the future?

8.7 It was an accident of policy that when maintained schools became subject to the national curriculum they were only belatedly allowed to continue to offer the separate sciences on condition that they taught and entered pupils for all three. Independent schools - because they are independent - meanwhile retained their freedom to offer any combination. Perhaps not unconnected with this is that while the take-up of A-level physics has fallen in the maintained sector it has held up well in independent schools. Those maintained schools which offer the physics GCSE also have more pupils going on to A-level physics (Chart 5.2 page 24).

Should maintained schools be allowed the same freedom as independent schools to offer any combination of the separate sciences?

8.8 A consequence of adopting science as the subject in the national curriculum is that the teachers are teachers of science, not of physics or biology. While the implicit intention for the existing double award combined science GCSE has been that there should be a balance between teachers from the different disciplines, it has not worked out that way because it is so much easier to attract biology graduates than physics graduates into teaching. In Chart 7.4 (page 46) we saw how from a third of the science PGCE intake in 1983, the proportion of physics teacher trainees (not all of whom have degrees in physics) has slipped to only one in eight in 2004. The difficulty of recruiting physics graduates has long been recognised and since 1986 various incentives have been offered. But with science as the subject in the national curriculum these incentives are also available to biology graduates so they do nothing to correct the imbalance within science. Whatever the merits of science as the subject if it is being mainly taught by biologists this is likely to affect the way it is perceived by pupils. The sixth form colleges and FE colleges (Box 6.6, page 39) argue that pupils interested in science are being swayed in the direction of their teachers' enthusiasms and that is often away from the physical sciences.

What can be done to ensure a more balanced representation of biology, chemistry and physics teachers within GCSE science?

8.9 Not all schools and colleges are suffering a decline in A-level physics. We heard in Box 6.7 (page 41) that a number of schools are proud of their success and wonder why they have not been consulted more. In returning questionnaires some wrote letters offering further help. The head of science in an 11-18 school in the Eastern Region wrote:

> "As you can see by the numbers of students studying AS and A-level in this, a fully comprehensive school, and the results obtained, we are doing something right. The

> projected numbers of 45 for next year's Year 12 who would like to study AS Physics are impressive since they represent about a quarter of the year group. In fact, my problem is being oversubscribed. The numbers require a much bigger pot of money for resources etc and laboratory space is now at a premium. If I can be of further help please get in touch with me."

8.10 This echoes a questionnaire comment cited in Box 6.7 from a grammar school also in the Eastern Region:

> "We are a girls' school with a highly successful physics department both in terms of uptake and outcome. We hear a lot about the 'national crisis' in science (especially female uptake) yet nobody appears interested in our success story. We have tried to share practice/become a centre of excellence."

8.11 In examining educational issues it is too easy to fall prey to pessimism, but it seems clear within the general trend of falling numbers for A-level physics there are some schools and colleges where take-up is buoyant. Are there useful lessons for others that can be learned from them?

Should the schools and colleges in which physics is thriving be studied to see what lessons can be learned from them?

8.12 It could be that they are mainly the schools with the most able pupils and the better-qualified teachers. Our analyses in Chapter 5 do show a clear relationship between teacher qualifications in physics and pupil performance in physics mediated by the schools. There is a discernible thread running through the data linking the better qualified teachers, the more able pupils and particular schools, often a grammar or a leading independent. But there are also wide differences between comprehensive schools, as the quote above illustrates. Similarly, not all grammar schools or independent schools have strong physics departments. What is it about these schools that makes the difference. Beyond the broad description in terms of teacher qualifications and pupil intake, are there particular things happening on the ground that could be transferred to other schools?

8.13 Conversely, it cannot be healthy to have such an uneven secondary education system. Pupils' chances in physics are limited more by the school they attend than their talent for the subject. Not only should we be learning lessons from successful schools, but also looking to see what can be done to level up the playing field, whether by sharing good practice, increasing the supply and improving the spread of physics teachers, or structural changes to improve pathways through to A-level and beyond.

Given that the opportunities for a young person with the talent and interest to study physics to a high level vary so widely across the educational system, what can be done to move towards a more level playing field?

8.14 Clearly, all schools should have the opportunity of appointing teachers of physics/physical processes well-qualified in physics. As we have shown, nearly a quarter of 11-16 schools lacked even one teacher who had studied physics to any level at university. While generally grammar schools, sixth-form colleges, FE colleges and independent schools had been able to recruit teachers qualified in physics, 56.3 per cent of secondary moderns, 40.1 per cent of 11-16 comprehensives and 17.5 per cent of up-to-18 comprehensives had less than one in four of their teachers qualified in the subject. But the current output of newly-trained physics teachers is barely sufficient to replace those who are retiring or otherwise leaving the profession. We have calculated that in order to give all state schools the opportunity of having at least a quarter of their teachers of physics qualified in physics over the next five years, training output needs to be raised from its present level of 450 to 750 a year. In other words, it needs to be increased by two-thirds. This is a tall order.

What can be done to increase the output of newly-trained physics teachers qualified in physics to replace the well-qualified teachers who are leaving and to enable all state schools to have the prospect of appointing at least some physics teachers qualified in the subject?

8.15 As we noted in paragraph 7.18 (page 50), already employment-based routes are making a major contribution and it is possible that extending the Teach First Scheme beyond London will increase this further. Gatsby Technical Education Projects is also piloting a scheme to train specialist physics teachers with insufficient physics background by topping up through extra tuition before, during and after PGCE courses. But traditional PGCE courses have become stuck in a rut and currently only bring forward about 280 new physics teachers a year. Can they be restructured to increase the flow?

8.16 It is strange that about a quarter of the physics graduates training to be teachers do so to become maths teachers when there is an acute shortage of physics teachers. In Chart 7.5 (Page 47) we showed that about a quarter of the physics graduates training to be teachers were actually training to be maths teachers. It could be that the laboratory work in physics puts some off, but there is no systematic information. An issue requiring further study is:

Why do so many physicists train to become maths teachers?

8.17 Among the suggestions for improving the present situation in physics (Chart 6.8, page 42) a recurring theme was the advantages of associating physics with maths rather than biology or chemistry. Several of the respondents suggested a PGCE in physics and maths instead of, or in addition to, that in combined science. Given the intrinsic importance of maths to physics this would seem a combination with more appeal and the respondents thought it would attract more physics graduates into teaching. Another issue, therefore, is:

Should we be thinking of linking physics with maths in PGCE course rather than with biology?

8.18 But would it also exacerbate the drift from physics, especially if attempts to solve the crisis in the supply of maths led to further incentives in this subject? Already about ten per cent of the physicists in schools do not teach physics and many of them are to be found teaching maths or computing/IT.

Conclusion

8.19 Physics in schools is at risk both through redefinition and lack of teachers with expertise in the subject. Many of those with degrees in physics came through the education system when physics was more clearly identifiable as a subject. Over half the physics lecturers in sixth form and further education colleges are aged over 50 as are nearly 40 per cent of the teachers in grammar and independent schools. They will be retiring soon and the shortages exacerbated. If physics is to survive in schools both as essential education and a platform for further study and research, there is an urgent need to address these issues.

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Appendix A: Methods

A.1 The population to be studied was teachers of physics teaching the subject to 14-18 year-olds in England and Wales, either on a separate course or as part of science. The whole range of institutions including maintained and independent schools, and sixth form and further education colleges, was to be included.

Fieldwork

A.2 There were three phases to the fieldwork: assembling and piloting the questionnaires; the survey itself in spring 2005; and a later, follow-up survey in September 2005 to obtain the 2005 summer examination results.

Phase 1. Devising and Piloting the Questionnaires

A.3 The head of the faculty or department responsible for physics in each of eight schools, four maintained and four independent, agreed to comment on a draft questionnaire devised by CEER. The research team visited each school in early December 2004 and the heads of department were asked to work through the questionnaire with us. As they went along they were asked to give their views on usefulness, content and clarity of the questions and the ease of completion, particularly whether departmental heads would have the information readily to hand and whether they would be inclined to respond if it had reached them cold. The heads of department were generous with their advice and the questionnaire was revised following each consultation. In addition, four heads of physics in the further education sector (including sixth form colleges) were consulted as to what modifications might be needed for the questionnaire to be applicable to their 16-18 year-old students

A.4 Variants of the questionnaire were arrived at for maintained and independent schools and for sixth form and further education colleges. Piloted drafts of the four variants were taken before the project's advisory group (consisting of representatives of the Institute of Physics, The Royal Society, the Association for Science Education and the Royal Academy of Engineering) on 3 February 2005. Following their advice some further amendments were made to the contents and layouts.

Phase 2: The Main Survey

The Questionnaires

A.5 Each questionnaire was produced as an eight-sided booklet with the items organised into five sections: science courses; teacher details; pupil numbers; examination results; and views on recruitment, training and deployment of teachers. The colleges were asked to provide information on full-time 16-19 year-old students only.

Science Courses

A.6 Respondents were asked to indicate the science courses offered in their institution from a list provided and add in any other KS4/AS/A-level science courses not specified. They were also asked to give the total number of periods in a normal timetable cycle as a basis for determining the relative time a teacher spent teaching physics or physical processes in science.

Teacher Characteristics and Qualifications

A.7 The main body of the questionnaire asked schools to list those teachers who were teaching physics/physical processes (Sc4) to Key Stage 4 and above. The questions were set out as a chart across two double-page sheets with columns for up to 11 teachers of physics (with a request to photocopy if there were more).

A.8 For each teacher the school/college was asked to give the main teaching subject, periods spent teaching physics/physical processes courses at GCSE (Single, Dual Award Science and Physics) and at AS, A2 level and the IB, and additionally periods teaching other science courses, other subjects and non-contact periods including administration duties. Other teacher details requested were: nature of contract (full-time or part-time, permanent or temporary); gender; the teacher's age; post; whether he/she was new member of staff in 2004/05. Details of academic qualifications were sought as: (1) the highest qualification in physics; (2) the highest academic qualification if not in physics; (3) the subject of that qualification; (4) teaching qualification; and (5) any higher degree(s) in Education.

A.9 There was also a section asking for details of any members of staff with at least a joint/combined honours degree in physics but not teaching any physics/physical processes in the school. As for the teachers of physics, the questions included: post; subject(s) and year group(s) taught; highest qualification in physics; main teaching subject(s); and whether a new member of staff in 2004/05.

Pupil Numbers

A.10 Information was requested on pupil numbers by type and level of course and by year group. The schools' version listed GCSE Single and Dual Award Science, GCSE Physics, AS and A2 Physics, IB Standard and Higher and AEA Physics. The colleges' variant excluded details for GCSE course and by year group.

Examination Results

A.11 In section four, schools were asked to fill in a table of examination entries and the number attaining each grade/level. The examinations included were Single and Dual Award Science, GCSE Physics and GCSE Applied Science, AS/A2 Physics, Chemistry, Biology, AS/A2 VCE Science, the International Baccalaureate and the Advanced Extension Award.

Recruitment, Training and Deployment

A.12 The last page of the Schools Questionnaire asked about additional training offered to teachers and science activities outside the timetabled lessons. All four variants invited a final comment on the recruitment and deployment of teachers in the school or college and more generally.

Distribution and Population

A.13 The questionnaire was sent out by post to all schools and colleges in England and Wales at the end of February 2005. The questionnaire, with a letter from the researchers, was sent in the first instance to the Headteacher/Principal to ask their permission and to enlist their support. The letter explained the purpose and importance of the survey, and how it was being funded. A letter from the Institute of Physics, The Royal Society, the Association for Science Education, the Royal

Academy of Engineering and Gatsby Technical Education Projects for the Gatsby Charitable Foundation, underlining the reasons for the survey was included. Headteachers/Principals were asked, if they were happy to participate, to pass the questionnaire together with an explanatory letter and the letter of support to their head of Physics/Science for completion.

A.14 The populations of schools and colleges in England and Wales were compiled as follows:

- The population of maintained secondary schools in England in 2004, identified by name, address and LEA, was obtained as an Excel file from the DfES's 'Edubase'.
- Maintained secondary schools in Wales were taken from *The Education Authorities Directory and Annual, 2004*.
- The Independent Schools Council kindly provided us with the names and addresses (and indeed address labels) of all independent schools admitting pupils at least to the age of 16 in England and Wales.
- A listing of sixth form colleges was sourced from the internet through the Sixth Form Colleges' Forum website.
- A listing of further education colleges was obtained from *The Education Authorities Directory and Annual, 2004* since the Learning and Skills Council, responsible for the colleges, was not able to provide a directory of the colleges.

A.15 A second copy of the questionnaire was sent out in April to those institutions which had not responded, directly to the Heads of Science/Physics.

Phase 3: The Follow-Up Survey

A.16 A follow up postal questionnaire was sent in late August after the release of the 2005 A-level and GCSE results 2005 to all respondents asking for information on entries and the number attaining each grade so that they were available to be considered in relation to the staff complements for that year. The examinations covered included GCSE Science, GCSE Physics, AS/A2 and the IB.

Data Preparation and Analysis

A.17 The questionnaire data were recorded according to prepared coding frames. Additional data on school and college characteristics, including eligibility for free school meals, were added from CEER's own data archive. School/college level data on performance at GCSE and post-16 were added to the datasets from the DfES's website.

A.18 Our computer specialist, Mandy-Diana Coughlan, took the lead in the compilation of the datasets, inputting the coded information into Excel files and verifying them. The datasets were then transferred into files of the Statistical packages for the Social Sciences Version 12 for analysis.

Response and Analysis

A.19 Chart A.1 shows the numbers of questionnaires distributed and response rates. Returns varied between the sectors with a good response from independent schools, sixth form colleges, further education colleges and grammar schools within the maintained sector. But the response from other maintained schools was below that which might have been expected.

A.20 A first step in the analysis was to determine the representativeness of the samples and how far they could be taken to reflect the situation nationally. Since the questionnaire asked for the summer 2004 A-level examination entries and the actual entries are published by the Joint Council for Qualifications as Inter-Awarding Body Statistics, it is possible to make a direct comparison. (The examination body for Northern Ireland, the CCEA publishes its results separately on its website, so they could be deducted from the overall figures to give those for England and Wales, the target populations for our survey).

A.21 Chart 2.1 shows there is generally good correspondence, but some tendency for the estimates to be above the actual entries, particularly among the comprehensive and secondary modern schools where the response rate was lowest.

Chart A.1: Respondents and Representativeness

Institution	Population	Respondents		A-level Entries 2004	
		N	Per cent	Actual	Estimated from Samples
Comprehensive	3,034	449	14.8	10,823	12,820
Grammar	164	77	47.0	3,550	3,530
Secondary Modern	159	24	15.1	106	140
Independent to 18	598	262	43.8	6,270	6,910
Sixth Form College	110	54	49.1	3,543	3,690
FE College	253	108	42.7	2,178	2,230
Total	4,318	974	226	26,470	29,320

A.22 The raw returns are likely to be giving a more favourable picture than actually exists and this must be borne in mind in interpreting the results. The response rate has, however, been sufficient to construct a 10 per cent sample of the system matching it very closely on the full range of national parameters available. These included: for maintained schools, region, size, type, funding category, age range, gender mix and specialism (although some analyses have been undertaken by specialism throughout the report they are described collectively as comprehensives, including the city technology colleges); for independent schools, region, size, type, age range, gender mix, day or boarding, and membership of particular association; and for sixth form and further education colleges, region and numbers of students 16-18. Appendix B shows the extent to which the sample corresponds to these characteristics.

A.23 While matching in this way does not correct for the initial bias, it does ensure representation of the different types of institution in proportion to their presence in the population. Within any cell the institutions to be included were drawn randomly.

All teachers of physics or with qualifications in physics recorded by these institutions form the database from which we report the characteristics of the physics teaching force in Chapter 2.

A.24 In examining the relationship between teacher qualifications and pupil performance the 2004 examination results collected in the initial survey were used since these were all that were available during the main period of the research. A follow-up survey was conducted in late August 2005 requesting the 2005 results. Of the original 974 respondents, 403 (41.4 per cent) provided the necessary information in time for it to be analysed. In all cases the correlations between the 2005 and 2004 results were highly significant: dual award science, $r = 0.946$, $df = 281$; GCSE physics, $r = 0.804$, $df = 160$; A-level physics, $r = 0.668$, $df = 204$. It is remarkable how little the pattern of GCSE and A-level results changed across the schools and colleges between the years. The correlation for A-level physics is somewhat lower partly because of attenuation of range (only some pupils in some schools get to take it) and partly because some schools have very few entrants leaving their score dependent on the vagaries of individual performance (schools with three entrants or fewer were excluded). The high degree of consistency found justifies using the 2004 results.

Appendix B: Samples Compared to National Distributions

Institutions

B.1 The population to be studied was all maintained secondary schools, independent schools with pupils at least up to age 16, sixth form colleges and further education colleges in England and Wales. The population frames were established from *Statistics of Education, Schools in England, 2004*: *The Education Authorities Directory and Annual 2004* (for secondary schools in Wales and further education colleges), the mailing list of the Independent Schools Council, and the Sixth Form colleges' website. These yielded a total of 4,318 institutions as listed in Chart B1. From the total response of 974 institutions a ten per cent sample was randomly chosen as described in Appendix A to fill the cells matching the population as closely as possible. Chart B1 gives the breakdown of the sample by institution.

Chart B1: Ten Per Cent Sample by Institution

Institutions	National		Sample	
	N	%	N	%
Comprehensive	3,034	70.2	304	70.4
Grammar	164	3.8	16	3.7
Secondary Modern	159	3.7	16	3.7
Independent	598	13.8	60	13.9
Sixth Form College	110	2.5	11	2.5
FE College	253	5.9	25	5.8
Total	**4,318**	**100.0**	**432**	**100.0**

B.2 The following charts show the correspondence between the sample and the national distribution for a range of characteristics for, in turn, the maintained schools, independent schools, sixth-form colleges and the further education colleges.

Maintained Schools

B.3 Samples for England and Wales were drawn separately, with in both cases the initial matching being made for a cross-tabulation of region by school size. As far as possible, further adjustments were made to match other characteristics. From the *Statistics of Education, Schools in England, 2004* information was available on the distribution of schools by region, size, type, funding category, age range, and gender mix. Details by specialism were available from the specialist schools site at www.dfes.gov.uk. The population for Wales was compiled from *The Education Authorities Directory and Annual 2004* and the *Schools in Wales, General Statistics, 2004*.

Chart B2: Maintained Schools by Region

Region	National N	National %	Sample N	Sample %
North East	155	4.6	18	5.4
North West	476	14.2	46	13.7
Yorks & Humber	318	9.5	32	9.5
East Midlands	291	8.7	25	7.4
West Midlands	372	11.1	39	11.6
East of England	340	10.1	38	11.3
Inner London	132	3.9	6	1.8
Outer London	273	8.1	26	7.7
South East	476	14.2	44	13.1
South West	297	8.8	39	11.6
Wales	227	6.8	23	6.8
Total	**3,357**	**100.0**	**336**	**100.0**

Chart B3: Maintained Schools in England by Size

	National N	National %	Sample N	Sample %
Up to 400	65	2.1	7	2.2
401 – 700	465	14.9	53	16.9
701 – 1000	1057	33.8	106	33.9
1001 – 1300	878	28.1	71	22.7
1301 – 1600	494	15.7	57	18.2
1601 or more	171	5.5	19	6.1
Total	**3,130**	**100.1**	**313**	**100.0**

Chart B4: Maintained Schools in England by Sixth Form Size

	National N	National %	Sample N	Sample %
Up to 50	81	4.6	4	2.3
51 – 100	245	13.8	18	10.4
101 – 150	359	20.3	25	14.5
151 – 200	370	20.9	26	15.0
201 – 250	302	17.0	41	23.7
251 or more	415	11.9	59	34.1
Total	**1772**	**100.0**	**173**	**100.0**

Chart B5: Maintained Secondary Schools in Wales by Size

	National		Sample	
	N	%	N	%
Upto 400	8	3.5	2	8.7
401 – 600	31	13.7	1	4.3
601 – 800	47	20.7	5	21.7
801 – 1000	49	21.6	5	21.7
1001 – 1500	76	33.5	8	34.8
1501 – 2000	14	6.2	2	8.7
2001 or more	2	0.9	0	0.0
Total	**227**	**100.0**	**23**	**99.9**

Chart B6: Maintained Schools by Type

	National		Sample	
	N	%	N	%
Comprehensive	3034	90.4	304	90.5
Grammar	164	4.9	16	4.8
Secondary Modern	159	4.7	16	4.8
Total	**3,357**	**100.0**	**336**	**100.0**

Chart B7: Maintained Schools by Funding Category

	National[1]		Sample[2]	
	N	%	N	%
Community	2415	66.4	217	64.6
Voluntary Aided	573	15.8	56	16.7
Voluntary Controlled	126	3.5	12	3.6
Foundation	522	14.4	51	15.2
Total	**3636**	**100.1**	**336**	**100.0**

1. Includes Middle deemed Secondary for England.
2. Middle Schools not included in survey.

Chart B8: Maintained Schools by Age Range

	National		Sample	
	N	%	N	%
Up to 16	1,412	42.1	145	43.2
Up to 18	1,945	57.9	191	56.8
Total	**3,357**	**100.0**	**336**	**100.0**

Chart B9: Maintained Schools by Gender of Pupils

	National		Sample	
	N	%	N	%
Mixed	2940	87.6	298	88.7
Girls'	230	6.9	23	6.8
Boys'	187	5.6	15	4.5
Total	**3,357**	**100.1**	**336**	**100.0**

Chart B10: Maintained Schools in England by Specialism

	National[1]		Sample	
	N	%	N	%
Technology	546	17.4	53	16.9
Sports	283	9.0	22	7.0
Arts	304	9.7	32	10.2
Languages	202	6.5	24	7.7
Science	225	7.2	35	11.2
Maths & Computing	153	4.9	16	5.1
Business & Enterprise	146	4.7	7	2.2
Other[2]	96	3.1	12	3.8
Non-Specialist	1,175	37.5	112	35.8
Total	**3,130**	**100.0**	**313**	**99.9**

1. Classification based on status at September 2004 as given on www.dfes.gov.uk specialist schools site (February 2005)

2. Other for national population includes 35 Engineering, 18 Humanities, 4 Music and 39 Combined Specialisms; for sample. Other = 3 Engineering, 3 Humanities, 6 Combined Specialisms.

Independent Schools

B.4 The population for independent schools was defined by the mailing list of the Independent Schools Council cross-checked against *The ISC Guide to Accredited Independent Schools, 2004*.

B.5 As with maintained schools the initial matching through a cross-tabulation of schools by region and size. Within those cells further matching was undertaken by, type, age range, gender mix, by whether or not boarding and Association membership.

Chart B11: Independent Schools by Region

Region	National		Sample	
	N	%	N	%
North East	19	3.2	2	3.3
North West	53	8.9	5	8.3
Yorks & Humber	37	6.2	4	6.7
East Midlands	31	5.2	3	5.0
West Midlands	51	8.5	5	8.3
East of England	73	12.2	7	11.7
Inner London	34	5.7	3	5.0
Outer London	57	9.5	6	10.0
South East	157	26.3	16	26.7
South West	72	12.0	7	11.7
Wales	14	2.3	2	3.3
Total	**598**	**100.0**	**60**	**100.0**

Chart B12: Independent Schools by Size

	National		Sample	
	N	%	N	%
Up to 400	219	36.6	20	33.3
401 – 700	198	33.1	27	45.0
701 – 1000	128	21.4	10	16.7
1001 – 1300	40	6.7	2	3.3
1301 – 1600	12	2.0	1	1.7
1601 or more	1	0.2	0	0.0
Total	**598**	**100.0**	**60**	**100.0**

Chart B13: Independent Schools by Sixth Form Size

	National		Sample	
	N	%	N	%
Up to 50	81	15.9	7	13.7
51 – 100	133	26.1	15	29.4
101 – 150	106	20.8	12	23.5
151 – 200	80	15.7	8	15.7
201 – 250	53	10.4	4	7.8
251 or more	56	11.0	5	9.8
Total	**509**	**99.9**	**51**	**100.0**

Chart B14: Independent Schools by Age Range

	National		Sample	
	N	%	N	%
Up to 16/17	89	14.9	9	15.0
Up to 18/19	509	85.1	51	85.0
Total	**598**	**100.0**	**60**	**100.0**

Chart B15: Independent Schools by Type

	National[1]		Sample[2]	
	N	%	N	%
Selective	461	78.9	46	79.3
Non-Selective	123	21.1	12	20.7
Total	**584**	**100.0**	**58**	**100.0**

1. No information on 14 schools.
2. No information on 2 schools.

Chart B16: Independent Schools by Gender of Pupils

	National		Sample	
	N	%	N	%
Mixed	302	50.5	30	50.0
Girls'(inc mixed VIth)	215	36.0	22	36.7
Boys'(inc mixed VIth)	81	13.5	8	13.3
Total	**598**	**100.0**	**60**	**100.0**

Chart B17 Independent Schools by Boarding

	National		Sample	
	N	%	N	%
Day only	300	50.2	31	51.7
Day and Boarding	290	48.5	28	46.7
Boarding only	8	1.3	1	1.7
Total	**598**	**100.0**	**60**	**100.0**

Chart B18: Independent Schools by Association Membership

	National		Sample	
	N	%	N	%
HMC	207	34.6	21	35.0
GSA	195	32.6	20	33.3
SHMIS	66	11.0	6	10.0
ISA	122	20.4	12	20.0
IAPS only	6	1.0	1	1.7
AGBIS only	2	0.3	0	0.0
Total	**598**	**100.0**	**60**	**100.0**

Sixth Form Colleges

B.6 The national population of sixth form colleges was obtained by an analysis of the listing on the Colleges' website. The 11 colleges included in the structured sample were arrived at from a cross-tabulation by region and number of 16-18 year-olds. The number of 16-18 year-olds was obtained from the DfES performance tables website.

Chart B19: Sixth Form Colleges by Region

Region	National N	National %	Sample N	Sample %
North East	7	6.4	1	9.1
North West	24	21.8	1	9.1
Yorks & Humber	11	10.0	1	9.1
East Midlands	5	4.5	1	9.1
West Midlands	12	10.9	1	9.1
East of England	9	8.2	1	9.1
Inner London	7	6.4	1	9.1
Outer London	7	6.4	1	9.1
South East	25	22.7	2	18.2
South West	2	1.8	1	9.1
Wales	1	0.9	0	0.0
Total	**110**	**100.0**	**11**	**100.0**

Chart B20: Sixth Form College by Roll 16-18

	National N	National %	Sample N	Sample %
0 – 500	6	5.6	1	9.1
501 – 1000	25	23.1	2	18.2
1001 – 1500	48	44.4	5	45.5
1501 – 2000	20	18.5	2	18.2
2001 – 2500	8	7.4	1	9.1
2501 or more	1	0.9	0	0.0
Total	**108**	**99.9**	**11**	**100.0**

Further Education Colleges

B.7 The national population of further education colleges was obtained by analysis of the listing in *The Education Directory and Annual, 2004*. The colleges included in the sample were chosen in the same way as the sixth form colleges. But no information on numbers of 16-18 year-olds was available for the Welsh FE colleges.

Chart B21: Further Education Colleges by Region

Region	National		Sample	
	N	%	N	%
North East	14	5.5	1	4.0
North West	34	13.4	4	16.0
Yorks & Humber	20	7.9	2	8.0
East Midlands	21	8.3	2	8.0
West Midlands	34	13.4	3	12.0
East of England	19	7.5	2	8.0
Inner London	13	5.1	1	4.0
Outer London	18	7.1	2	8.0
South East	32	12.6	3	12.0
South West	28	11.1	3	12.0
Wales	20	7.9	2	8.0
Total	**253**	**100.0**	**25**	**100.0**

Chart B22: Further Education Colleges by Roll 16-18

	National[1]		Sample	
	N	%	N	%
Up to 1000	37	16.2	4	17.4
1001 – 1500	60	26.3	6	26.1
1501 – 2000	40	17.5	4	17.4
2001 – 2500	34	14.9	3	13.0
2501 – 3000	21	9.2	2	8.7
3001 or more	36	15.9	4	17.4
Total	**228**	**100.0**	**23**	**100.0**

1. No information on 25 colleges.

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