A study into the professional views and needs of science teachers in primary and secondary schools in England

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EXECUTIVE SUMMARY

INTRODUCTION

1.1. This report presents the findings of a study into the views and needs of teachers of science in primary and secondary state schools concerning:

- their career-long continuous professional development (CPD);
- the identification, collection and spread of good practice in science teaching;
- the support for school science provided by the many private and public sector organisations and institutions; and
- the use of Information and Communication Technology (ICT) for these purposes.

1.2. The study was undertaken by the School of Education, King's College London during June and July 1999 through:

- 20 focus groups involving more than 150 teachers from 50 schools in five regions of England: and
- a questionnaire survey of a randomly selected sample of 1973 primary and 735 secondary state schools in England.

1.3. Three questionnaires were sent to each school – one for the headteacher, one for a teacher of science with less than five years experience, and one for a more experienced teacher of science. These questionnaires are reproduced in Annex 2 which also contains further details of the methodology used.

1.4. A total of 2,355 questionnaires (29% of the total of 8124 distributed) were returned from 1279 schools (47% of the total sample) as follows:

	Primary		Secondary
Number of Schools	745 (38%)		505 (68%)
Number of Headteachers	565 (29%)		360 (49%)
Total number of teachers	854 (22%)		576 (42%)
with five or less years' experience	289	223	
with more then five years' experience	565		353

1.5. The study was commissioned by the Office of Science and Technology to inform work by the Council for Science and Technology on the question of what would make a material difference to aid primary and secondary teachers teach science to their pupils during their compulsory schooling, and particularly to those between the ages of 9 to 14 years old. In order to found its advisory report to the Prime Minister on as firm an evidential base as possible, the Council required a robust up to-date picture from the teacher's viewpoint.

1.6. The key findings of the picture revealed by the study are summarised below. Further and fuller details are presented in the remainder of the report, along with our conclusions and acknowledgements. Annex 1 contains a glossary of the abbreviations and acronyms used in the text.

1.7. The study did not encompass issues concerning the overarching framework within which science teachers work since they fell outside the scope of the Council's work. Hence elements such as the curriculum, assessment and inspection frameworks were purposely excluded. So too were generic matters such as school inspections, performance tables, teacher appraisal, conditions of employment including pay, teacher career structures, recruitment and retention, and the initial training of new teachers of science before they obtain Qualified Teacher Status.

KEY FINDINGS

(a) The Teachers' INSET

1.8. Generally, the participating teachers were not engaged in a subject related, classroom based, systematic process of CPD matched to their individual needs. Dissatisfaction with the use made by schools of the five training days per annum was widespread.

1.9. Many teachers in the focus groups did not fully appreciate the term CPD and reported that INSET in their schools was being taken up increasingly by whole school issues, general topics such as ICT, and matters of administration rather than teaching. They were also critical of the adequacy of existing appraisal arrangements for identifying their individual strengths, and of just how little say they had in their individual CPD, or the courses that they did attend. Both primary and secondary teachers reported that opportunities to build on their initial training were very limited and tailed away sharply once their Qualified Teacher Status (QTS) was confirmed at the end of the first year of their careers. In the questionnaires returned:

- less experienced teachers had attended fewer courses than their more experienced colleagues;

- most teachers had received some form of INSET during the preceding school year, mainly from colleagues in their own school (primary 85% and secondary 86%) compared to other sources of INSET (primary 58% and secondary 68%);

- the secondary teachers were less satisfied with their INSET in 1998/99 than their primary colleagues with the proportion who found it to be less than generally useful ranging between 42% and 63% depending on its subject e.g. classroom management. The equivalent range at the primary level was 34%-50%;

- very few teachers had obtained a recognised qualification through their INSET;

- unprompted, a significant number of secondary headteachers commented that their school science departments were not developing and improving as quickly as others;

- there was a significant difference in view between the teachers on the one hand and the headteachers on the other about the relative merits of INSET within and outside school. Generally, the teachers rated external INSET more highly while the headteachers held the opposite view.

(b) The Teachers' Needs and Requirements for CPD

1.10. Overall, the respondents felt strongly that the status and quality of CPD for science teaching needed to be raised substantially. A strong theme running through the teachers' responses was the pressing need for an organised system of continuous professional development. Above all else, the teachers wanted a user-friendly system through which they could develop and strengthen their professional practice, principally by learning from their peers. Subject knowledge, pedagogy, pupil learning and classroom management all featured highly on their list of INSET rankings.

1.11. Specifically, the teachers wanted more opportunities, not only to share experience and good practice with colleagues in their own school and in other schools, but also to compare their practice with others in order to identify their individual CPD needs. They also wanted higher quality INSET and more emphasis on classroom focused support. In their view, INSET at present was insufficiently focused on their individual needs; involved too little in the way of practical activity rather than pure theory; and too rarely permitted interaction with other teachers.

1.12 They attached considerable importance to matters of course quality, to input in the form of training, help and advice from top class tutors/mentors, and to the opportunity to try out new teaching strategies, approaches, styles, methods and materials in their classes. They further valued the benefits of extended courses which provided sufficient time for their reflective learning with colleagues from other schools

1.13. In the focus groups, many teachers were unclear about the opportunities that they had to develop personally and professionally throughout their careers. They also highlighted difficulties in identifying and accessing suitable products and services for their individual CPD, and the very real constraints of time and money which presently militated against their CPD.

1.14 In the questionnaires returned:

- 85% of the primary teachers and 86% of the secondary teachers had drawn on the advice of other colleagues during 1998/99;

- in contrast, they had made far less use of LEA advisors - 49% primary and 51% secondary; of teachers' centres - 40% primary and 25% secondary; and of the Association for Science Education - 39% primary and 56% secondary;

- of those teachers who had contacted their LEA advisors, 24% of primary teachers and 31% of secondary teachers rated the help that they received as 'poor'. Teachers in urban schools were more critical about this than the teachers in suburban or rural schools;

- of those teachers who had experience of their teachers' centre during the year, 31% of primary teachers and 42% of secondary teachers rated the help that they received as 'poor'.

(c) The Teachers' Levels of Confidence

1.15 Further aspects of the teachers' CPD needs were revealed by this aspect of the questionnaires. Thus of those returned:

- In both primary and secondary schools, teachers with more experience reported feeling more confident than their less experienced colleagues, but there were significant variations, especially between the science topics taught and between key stages 3 and 4;

Among the primary teachers:

- 57% had a lot of (as opposed to 'some' or 'little or no') confidence in teaching Science at key stage 2, appreciably lower than the figures for the other core subjects: English (66%) and Mathematics (63%);

- only 44% of the teachers had a lot of confidence in teaching the programme of study at key stage 2 for *Sc1 - Experimental and Investigative Science*, and 47% for *Sc4 - Physical Processes.*

- Science is one of three core subjects in the National Curriculum. 13% of the primary teachers reported teaching science for 1 hour each week, 55% for 2 hours, 19% for 3 hours and 11% for more than 3 hours per week.

Among the secondary teachers:

- 89% of teachers had a lot of confidence in teaching *Sc1 - Experimental and Investigative Science* at key stage 3, dropping to 79% at key stage 4. For other programmes of study in science, this drop in confidence between the two key stages was more marked, e.g. 81% of teachers had a lot of confidence in teaching *Sc4 - Physical Processes* at key stage 3, dropping to 50% at key stage 4.

- At the start of their career, almost all of the teachers felt well prepared for teaching some or all of the science curriculum.

- Teachers with a PGCE reported being the most well-prepared for teaching science compared with those teachers who had undertaken other modes of training (or none at all).

(d) The Teachers' Subject Qualifications

1.16 Similarly, further information about the teachers' CPD needs was provided by their subject qualifications. Thus of those returned:

- Among the primary teachers teaching science at key stage 2, 19% had no biology qualification at all, 42% no chemistry qualification and 47% no physics qualification. The percentages who had at least an A level or higher qualification were 31% for biology, 16% for chemistry and 11% for physics.

- Among the secondary teachers teaching key stage 4 science topics, 26% of those teaching biology topics did not have an A-level in the subject, neither did 13% of those teaching chemistry topics and 29% of those teaching physics topics. Furthermore, 39% of those teaching key stage 4 biology topics did not have a degree in biology, 51% of those teaching key stage 4 chemistry topics did not have degree in chemistry, and 66% of those teaching key stage 4 physics topics did not have a degree in physics.

(e) Teachers' Views on Third Party Support for School Science Teaching

1.17 Generally, the participating teachers made little use of the third party support that was available to them. They felt that the materials did not meet their needs with regard to classroom teaching, and that many materials were out of date with respect to the new versions of the National Curriculum. Teachers also generally felt that they were inundated with materials from numerous sources and did not have the time to identify what was useful. This problem was exacerbated by a lack of training on how to use the materials effectively and a lack of independent sources of advice on the value of such materials. From the questionnaires returned:

- Fewer than 10% of the primary and secondary teachers reported being frequent users of third party materials, although primary teachers reported making 'occasional' use of materials from museums (63%), industry (32%) and the ASE (28%). Secondary teachers made 'occasional' use of materials from industry and learned societies (both 50%), the ASE (45%) and museums (41%). However, primary teachers in particular reported not being aware of many of the third party resources, e.g. 26% of primary teachers were not aware of resources available through the ASE, and 34% were not aware that resources were available from Government agencies.

- In contrast to their use of third party materials, primary teachers reported 'often' using textbooks (43%), other books (61%) and videos (26%); and secondary teachers reported 'often' using set textbooks (89%), other books (46%) and videos (51%) in their teaching of science.

- Both primary teachers (89%) and secondary teachers (87%) would like third party sponsors to supply more material on ideas for science investigations, as well as running courses for teachers (primary 81%, secondary 78%).

- Primary and secondary teachers reported different opinions about the quality of science advice they received from different sources. Advice from other teachers was rated as 'good' or 'satisfactory' by 96% of primary teachers and 97% of secondary teachers. The corresponding results for 'good' or 'satisfactory' for other

sources were: advice from LEA advisors, 76% primary and 69% secondary; advice from teachers' centres, 69% primary and 58% secondary; and advice from the ASE, 82% primary and 90% secondary.

(f) Teachers' use of Information and Communication Technology

1.18 ICT is an aspect of the science curriculum that has lately received significant funding for resources and training in schools, in particular because of the introduction of the National Grid for Learning (NGfL). However, despite this investment, the level of use of computers in science was reportedly rather low. From the questionnaires returned:

- The NGfL was used only 'rarely' by 71% of primary teachers of science and by 72% of secondary teachers of science. In the focus group sessions, teachers reported not finding the NGfL particularly helpful to their teaching of science.

- 42% of primary teachers reported using computers 'often' in their science teaching, compared with only 9% of secondary science teachers.

- 43% of primary teachers reported using computers 'often' for the preparation of teaching materials for science, compared with 65% of secondary science teachers.

- 35% of primary teachers reported using computers 'often' for administration relating to their science teaching, compared to 62% of secondary teachers.

- The figures for administration and preparation of materials might be lower for primary teachers because they have less non-contact time available.

- The main constraint on teachers' use of ICT in their science teaching was reported as lack of time (by 88% of primary teachers and 86% of secondary teachers). The next most important factor for primary teachers was lack of knowledge ('know-how') about the use of ICT (56%). However, for secondary teachers the next most important constraining factor was lack of access to the appropriate equipment (65%).

SURVEY RESULTS

I. THE RESPONDENTS

2.1 A random sample of 2000 maintained schools teaching any KS2 year group and 750 maintained schools teaching any KS3 year group was drawn from the National Foundation for Educational Research's Register of Schools. Independent and Special schools, and 6th Form colleges were excluded. The schools were stratified by achievement (National Curriculum Science results), size of school and geographical location. Out of the total of 2750 schools selected to form the sample, 34 schools were withdrawn by the LEA leaving 2716 schools that were sent the questionnaires.

2.2 The profile of the schools from which completed questionnaires were received from headteachers were as follows (Tables 1-3):

Table 1. School Location

	Sector	
Location	*Primary (n=565) %*	*Secondary (n=359) %*
Urban	46	45
Suburban	28	25
Rural	16	20
No response	10	10

Table 2. School size (n=565 primary; n=341 secondary)

	Number of pupils per school			
Sector	*0-100*	*101-500*	*501-1000*	*1000+*
Primary (n)	96	400	67	0
Primary %	17	71	12	0
Secondary (n)	2	18	190	131
Secondary %	1	5	56	38

Table 3a. Size and geographical area: primary schools

		Number of pupils		
Location		*0-100*	*101-500*	*501-1000*
Urban (n=197)	*Number*	5	159	33
	%	<3	81	17
Suburban (n=167)	*Number*	6	133	28
	%	<4	80	17
Rural (n=196)	*Number*	84	106	5
	%	43	54	3

Table 3b. Size and geographical area: secondary schools

		Number of pupils			
Location		*0-100*	*101-400*	*401-1000*	*1000+*
Urban (n=133)	*Number*	1	5	78	49
	%	<1	4	59	37
Suburban (n=132)	*Number*	1	6	68	56
	%	<1	5	52	42
Rural (n=90)	*Number*	0	7	49	34
	%	0	8	54	38

2.3 The general characteristics of the teachers who completed and returned questionnaires were as follows (Tables 4-6):

Table 4. By age and gender

	Teachers' age					Gender	
Sector	*21-30 years %*	*31-40 years %*	*41-50 years %*	*51-60 years %*	*60+ years %*	*Female %*	*Male %*
Primary (n=854)	29	23	35	12	<1	79	21
Secondary (n=576)	31	23	31	14	<1	42	58

Table 5. By length of experience

	Length of teaching experience				
Sector	*0-5 years %*	*6-10 years %*	*11-20 years %*	*21-30 years %*	*30+ years %*
Primary (n=854)	34	16	20	26	4
Secondary (n=576)	39	8	24	25	4

Table 6a. Primary teachers by school size and location (n=854)

		Number of pupils			
Location		*0-100*	*101-500*	*501-1000*	*Total*
Urban	*Number*	1	242	10	253
	%	<1	96	<4	100
Suburban	*Number*	3	295	17	317
	%	<1	93	5	100
Rural	*Number*	98	159	2	261
	%	38	61	<1	100
No response	*Number*	1	22	0	23
	%	4	96	0	100

Table 6b. Secondary teachers by school size and location (n=576)

		Number of pupils			
Location		*101-500*	*501-1000*	*1001+*	*Total*
Urban	*Number*	13	104	57	174
	%	7	60	33	100
Suburban	*Number*	21	124	121	266
	%	8	47	45	100
Rural	*Number*	11	61	49	121
	%	9	50	41	100
No response	*Number*	2	4	8	14
	%	14	29	57	100

II. THE HEADTEACHERS' PERSPECTIVES

A. INSET PRACTICES

2.4 Among the primary headteachers, 50% reported that they themselves decided how INSET funds were allocated (Table 7a). The corresponding figure for secondary schools was 15% (Table 7b). The combined figure for allocating funding by the head or a colleague were similar in primary and secondary schools – primary 75%, secondary 76%. In 11% of the primary schools and 9% of the secondary schools, INSET funding was allocated on the basis of individuals bids from teachers (Tables 7a/b).

Table 7a. How INSET funds were allocated in the primary schools (n=565)

	Schools
Method of allocation	**%**
Head decides	50
Colleague decides	25
Budget devolved to individuals	6
Bids from Individuals	11
Other	32

Table 7b. How INSET funds were allocated in the secondary schools (n=360)

	Schools
Method of allocation	**%**
Head decides	15
Colleague decides	61
Budget devolved to individuals	29
Bids from Individuals	9
Other	29

NB In tables 7a/b, heads were able to choose more than one response, so the figures add up to more than 100%

2.5 88% of the primary heads and 84% of the secondary heads 'often' (rather than 'occasionally' or 'rarely') determined INSET needs in line with School Development Plans (Tables 8a/b). The second most important consideration was individual requests (41%, 'often' in primary schools and 51% 'often' in secondary schools).

Table 8a. Basis for determining INSET funding allocations in the primary schools (n=565)

Basis	Often %	Occasionally %	Rarely %	Never/Omitted %
Individual Requests	41	56	2	2
Informed by the School Development Plan	88	11	0	1
Senior Colleagues	22	50	14	14
Examination Results	20	50	22	8
LEA Inspector	7	50	32	11
Ofsted	31	58	7	4
Other	9	2	1	87

Table 8b. Basis for determining INSET funding allocations in the secondary schools (n=360)

Basis	Often %	Occasionally %	Rarely %	Never/Omitted %
Individual Requests	51	47	1	2
Informed by the School Development Plan	84	15	0	1
Senior Colleagues	33	62	2	3
Examination Results	12	58	23	7
LEA Inspector	5	37	52	7
Ofsted	18	60	15	7
Other	11	7	1	81

NB In tables 8a/b, heads were able to choose more than one response, so the figures add up to more than 100%

B. PRIORITIES FOR INSET

2.6 For inexperienced teachers of science, the primary headteachers attached most importance to improving their 'Subject Knowledge' and 'Teaching Skills' while the secondary headteachers rated 'Teaching Skills', 'How Students Learn', 'Raising Achievement' and 'Class Management' as the most important (Tables 9a/b).

Table 9a. The importance that the primary headteachers attached to different topics for INSET for less-experienced teachers of science (n=565)

	Level of importance			
Topic	*High %*	*Average %*	*Low %*	*No response %*
Subject knowledge	62	32	3	4
Teaching skills	62	29	4	4
How students learn	45	44	5	5
Target setting	41	47	6	5
Raising achievement	55	37	3	4
Class Management	42	42	11	5

Table 9b. The importance that the secondary headteachers attached to different topics for INSET for less-experienced teachers of science (n=360)

	Level of importance			
Topic	*High %*	*Average %*	*Low %*	*No response %*
Subject knowledge	32	47	15	6
Teaching skills	79	16	1	3
How students learn	77	17	3	4
Target setting	42	48	4	5
Raising achievement	74	20	1	4
Class Management	68	26	2	4

NB In tables 9a/b, heads were able to choose more than one response, so the figures add up to more than 100%

2.7 Both primary and secondary headteachers viewed 'Raising Achievement' as by far the most important topic for INSET for experienced teachers of science. Secondary headteachers rated 'How Students Learn' and 'Middle Management' highly as INSET topics for more experienced science teachers (Tables 9c/d).

Table 9c. The importance that the primary headteachers attached to different topics for INSET for more-experienced teachers of science (n=565)

	Level of importance			
Topic	*High %*	*Average %*	*Low %*	*No response %*
Subject knowledge	42	46	10	2
Teaching skills	30	48	20	2
How students learn	30	46	21	3
Target setting	41	46	11	2
Raising achievement	60	34	5	1
Class Management	17	53	28	2
Departmental Management	28	41	23	8

Table 9d. The importance that the secondary headteachers attached to different topics for INSET for more-experienced teachers of science (n=360)

	Level of importance			
Topic	*High %*	*Average %*	*Low %*	*No response %*
Subject knowledge	22	51	23	5
Teaching skills	41	48	8	3
How students learn	66	27	5	2
Target setting	44	45	7	4
Raising achievement	81	15	2	2
Class Management	25	53	18	4

Departmental Management	64	29	4	4

C. FUNDS AVAILABLE FOR INSET

2.8 The amount of money available for INSET varied widely from school to school (Tables 10-11). The mean total amounts available in the primary schools were £4,140 and, in the secondary schools, £14,730.

2.9 The amount of money available per member of staff in primary schools varied from £20 to £3000 per teacher. In secondary schools, the figures ranged from £50 per teacher to £1500. The average amount was £445 in primary schools and £304 in secondary schools. [The mean size of schools was: primary 9.3 FTE; secondary 48.5 FTE].

Table 10. INSET funding available in the primary schools (n=565)

	Finance available per school (£K)				
	0-1	*1.1-5.0*	*5.1-10.0*	*10.1-15.0*	*15.0+*
Number of schools	35	325	108	24	6

Table 11. INSET funding available in the secondary schools (n=360)

	Finance available per school (£K)				
	0-5	*5.1-10.0*	*10.1-20*	*20.1-30.0*	*30.0+*
Number of schools	25	98	111	51	43

Table 12. Distribution of INSET funding per primary teacher (n=565)

	Teachers
Amount	**%**
£0-100	8
£101-300	17
£301-500	52
£501-1000	9
£1000+	15

Table 13. Distribution of INSET funding per secondary teacher (n=360)

	Teachers
Amount	**%**
£0-150	15
£151-300	38
£301-600	38
£601-1000	8
£1000+	<2

D. PRINCIPAL CONCERNS ABOUT INSET

2.10 The primary and secondary heads judged that the most significant constraints on INSET provision were the lack of time and the lack of finance for their science teachers to engage in substantial CPD, e.g. by studying for a higher qualification or by gaining/developing subject knowledge. Almost half of the primary and secondary headteachers were concerned about the availability of supply cover of sufficient quality. Science teachers' reluctance to take part in INSET was not seen as significant by the vast majority of heads (Tables 14a/b).

Table 14a. The primary headteachers' opinions about the relative significance of constraints on the provision of INSET (n=565)

	Perceived significance		
Constraint	*Very significant* %	*Significant* %	*Not significant* %
Teachers' time	48	32	18
Finance	46	37	15
Resources/fairness	23	48	24
Teacher reluctance	2	13	80
Lack of advice	9	32	54
Lack of supply cover	18	27	51
Other	7	1	1

Table 14b. The secondary headteachers' opinions about the relative significance of constraints on the provision of INSET (n=360)

	Perceived significance		
Constraint	*Very significant* %	*Significant* %	*Not significant* %
Teachers' time	36	42	20
Finance	35	43	21
Resources/fairness	21	49	28
Teacher reluctance	2	16	80
Lack of advice	8	37	53
Lack of supply cover	17	31	51
Other	4	4	4

2.11 In response to an open-ended question in the questionnaire, many headteachers indicated that their major concerns about raising levels of attainment in science were the lack of suitably qualified teachers of science, particularly in secondary schools, and the presence of teachers in science departments who were reluctant to develop their knowledge and skills. In these regards:

- 17% of the secondary headteachers commented that their science departments had not developed as quickly as other subjects for such reasons as weak management at the head of department level.

- 81% of the primary headteachers specifically mentioned the shortage of time limiting the provision and 52% mentioned access to professional development; the priority currently given to initiatives in literacy and numeracy meant that there were reduced opportunities and emphasis on professional development in science (40%); and that there was a shortage of funds for teacher release (29%). The next factor mentioned after this was a concern expressed about the lack of subject knowledge amongst many primary teachers.

E. ASSESSMENT OF INSET

2.12 Contrary to the views of their staff (Table 38b), the secondary headteachers generally judged INSET delivered in school by colleagues as being more useful for their science staff than INSET attended outside school (Table 15b).

Table 15a. The primary headteachers' assessment of the utility of INSET provided to their staff (n=565)

	Perceived utility		
Source	*Mostly useful* %	*Some use* %	*Little use* %
In school, from colleagues	54	38	3
In school, from outsiders	38	47	4
Out of school	38	52	6

Table 15b. The secondary headteachers' opinions about the utility of INSET provided to their staff (n=360)

	Perceived utility		
Source	*Mostly useful* %	*Some use* %	*Little use* %
In school, from colleagues	70	27	1
In school, from outsiders	42	50	2
Out of school	26	67	4

III. THE TEACHERS' PERSPECTIVES

A. SUBJECT QUALIFICATIONS

2.13 The match between teachers' subject qualifications and the subjects that they are teaching was explored both in the questionnaire survey and through the focus groups.

(i) Primary Teachers

2.14 All the primary school teachers taught across the curriculum. 15% of the primary teachers reported teaching science for 1 hour each week or less, 55% taught

science for 2 hours each week, 19% taught 3 hours per week and 11% taught science for more than 3 hours per week (Table 16).

Table 16. The number of hours per week of science taught by the primary teachers (n=854)

	Teachers	
Number of hours	*Number*	*%*
<1 hour/week	17	2
1 hour/week	114	13
2 hours/week	466	55
3 hours/week	165	19
4 hours/week	47	6
5 hours/week	18	2
>5 hours/week	26	3

2.15 A total of 60% of the primary teachers had a BEd degree or a BA/BSc plus a one-year primary Postgraduate Certificate in Education (PGCE) and another 31% possessed a teaching certificate (Table 17). Older teachers were the least highly qualified group (Table 18).

Table 17. The teaching qualification of the primary teachers (n=854)

Teachers possessing qualifications				
Certificate %	*PGCE %*	*BEd %*	*Degree + QTS %*	*Non %*
31	29	31	9	0

Table 18. The qualifications of the primary teachers by age (n=854)

	Teachers' age			
Type of qualification	*21-30 %*	*31-40 %*	*41-50 %*	*51-60 %*
Cert./Diploma (n=263)	1	2	65	32
PGCE (n=249)	34	39	23	4
BEd (n=262)	39	32	25	4
Degree+QTS (n=76)	76	12	8	3

2.16 The percentages of the primary teachers who had at least an A level or higher qualification in a science based subject were 31% for biology, 15% for chemistry, and 11% for physics. The percentages of primary teachers of science who had at least a first degree or greater were Biology 12%, Chemistry 4%, Physics 2% (Table 19a).

2.17 For teachers with 0-5 years' experience, the percentages with a degree were Biology 16%, Chemistry 4%, Physics 4%. While the percentages of those without any subject qualification were 19% for biology, 42% for chemistry and 47% for physics (Table 19a). The equivalent figures for teachers with 0-5 years' experience were only

slightly more satisfactory - 16% for biology, 34% for chemistry and 41% for physics (Table 19b).

Table 19a. The qualifications of the primary teachers by science subject (n=854)

	Qualification obtained					
Subject of qualification	*<O/GCSE %*	*O/GCSE %*	*A-level %*	*BSc %*	*MA %*	*PhD %*
Biology	19	50	19	11	<1	<1
Chemistry	42	42	12	3	0	<1
Physics	47	42	9	1	<1	0
All subjects	108	134	40	15	<1	<1

Table 19b. The qualifications of the primary teachers of science with 0-5 years' experience by science subject (n=289)

	Qualification obtained					
Subject of qualification	*<O/GCSE %*	*O/GCSE %*	*A-level %*	*BSc %*	*MA %*	*PhD %*
Biology	16	51	17	16	0	<1
Chemistry	34	51	11	4	0	<1
Physics	41	47	8	3	<1	0
All subjects	91	148	35	23	<1	1

Figures in the final row (All subjects) include teachers who have more than one A-level or O/GCSE pass in a science subject and so therefore exceed 100%

(ii) Secondary Teachers

2.18 A total of 82% of the secondary teachers had a BEd degree or a BA/BSc plus a one-year primary Postgraduate Certificate in Education (PGCE) and another 11% possessed a teaching certificate (Table 20). As with the primary teachers, younger teachers were the most highly qualified group (Table 21).

2.19 Among the teachers teaching key stage 3 science topics, the percentages of those without an A-level in the subject were:

37% of those teaching biology;
19% of those teaching chemistry;
37% of those teaching physics.
(Table 23a)

2.20 Among the teachers teaching key stage 4 science topics, the percentages of those without an A-level in the subject were:

26% of those teaching biology;
13% of those teaching chemistry;
29% of those teaching physics.
(Table 23c)

and the percentages of those without a related degree were:

39% of those teaching biology;
51% of those teaching chemistry;
66% of those teaching physics.
(Table 23d)

Table 20. The teaching qualification of the secondary teachers (n=576)

Teachers possessing qualifications					
Certificate %	*PGCE %*	*BEd %*	*Degree + QTS %*	*Non %*	*Other %*
11	75	7	4	2	1

Table 21. The teaching qualifications of the secondary science teachers by age (n=576)

	Teachers' age			
Type of qualification	*21-30 %*	*31-40 %*	*41-50 %*	*51-60 %*
Cert./Diploma (n=61)	0	3	46	51
PGCE (n=431)	38	26	28	8
BEd (n=40)	10	35	40	15
Degree+QTS (n=22)	32	9	32	27
None (n=13)	0	0	46	54
Other (n=9)	22	33	44	0

Table 22a. The qualifications of the secondary teachers of science by subject (n=576)

	Qualification obtained					
Subject taught	*<O/GCSE %*	*O/GCSE %*	*A-level %*	*BSc %*	*MA %*	*PhD %*
Biology	18	22	16	38	2	3
Chemistry	5	14	43	32	3	3
Physics	8	28	39	22	1	1
All subjects	10	64	99	93	6	7

Table 22b. The qualifications of the secondary teachers of science with 0-5 years' experience by subject (n=223)

	Qualification obtained					
Subject of qualification	*<O/GCSE %*	*O/GCSE %*	*A-level %*	*BSc %*	*MA %*	*PhD %*
Biology	15	18	17	43	1	4
Chemistry	6	16	42	28	3	4

Physics	10	30	38	17	1	1
All subjects	31	64	96	89	5	10

Table 23a. Percentage of teachers teaching each science at KS3 who had at least an A level in that subject (n=576)

	Teachers with at least an A-level
Science	*%*
Biology	63
Chemistry	81
Physics	63

Table 23b. Percentage of teachers teaching each science at KS3 who had a degree or more in that subject (n=576)

	Teachers with a first degree or higher
Science	*%*
Biology	47
Chemistry	38
Physics	24

Table 23c. Percentage of teachers teaching each science at KS4 who had at least an A level in that subject (n=576)

	Teachers with at least an A-level
Science	*%*
Biology	74
Chemistry	87
Physics	71

Table 23d. Percentage of teachers teaching each science at KS4 who had a degree or more in that subject (n=576)

	Teachers with a first degree or higher
Science	*%*
Biology	61
Chemistry	49
Physics	34

B. LEVELS OF CONFIDENCE

2.21 Reported levels of confidence in teaching science varied considerably depending, *inter alia*, on the area of the curriculum being taught, the length of experience of the teacher and whether the teacher was primary or secondary. As might be expected, teachers with fewer than five years' experience generally reported having less confidence in teaching science than did their more experienced colleagues (Tables 24-27).

(i) Primary Teachers

2.22 Generally, the primary teachers felt less confident in teaching Science in the National Curriculum at key stage 2 than in teaching the other two core subjects of English and Mathematics (Table 24).

Table 24. The primary teachers' confidence about teaching the core subjects at key stage 2

	Level of confidence		
Subject	*A lot* %	*Some* %	*Little/none* %
English	66	32	2
Mathematics	63	34	2
Science	57	40	3

Table 25a. The primary teachers' confidence about teaching science at key stage 2 by experience

	Level of confidence		
Years' teaching	*A lot %*	*Some %*	*Little/none %*
0-5 (n=289)	45	51	4
6-10 (n=138)	65	33	2
11-20 (n=174)	65	32	2
21-30 (n=221)	62	37	1
30+ (n=31)	61	32	6
All teachers	57	40	3

Table 25b. The primary teachers' confidence about teaching English at key stage 2 by experience

	Level of confidence		
Years teaching	*A lot %*	*Some %*	*Little/none %*
0-5 (n=289)	56	40	4
6-10 (n=138)	67	31	1
11-20 (n=174)	69	29	2
21-30 (n=221)	74	24	1
30+ (n=31)	77	23	0
All teachers	66	32	2

Table 25c. The primary teachers' confidence about teaching mathematics at key stage 2 by experience

	Level of confidence		
Years teaching	*A lot %*	*Some %*	*Little/none %*
0-5 (n=289)	52	44	3
6-10 (n=138)	62	36	2
11-20 (n=174)	70	28	2
21-30 (n=221)	71	27	2
30+ (n=31)	77	23	0
All teachers	63	34	2

2.23 Only 45% of the primary teachers with fewer than five years' experience reported having a lot of confidence in teaching science compared with over 60% of their more experienced colleagues (Table 25a). Levels of confidence also varied with the four programmes of study of Science at key stage 2, namely *Sc1 - Experimental and Investigative Science; Sc2 - Life and Living Processes, Sc3 - Materials and their Properties*, and *Sc4 - Physical Processes* (Table 26). For instance, while 67% of the teachers reported having a lot of confidence teaching *Sc2 - Life and Living Processes*, only 44% reported having a lot of confidence teaching *Sc1 - Experimental and Investigative Science*, and 47% teaching *Sc4 - Physical Processes* (Table 26).

Table 26. The primary teachers' confidence in teaching specific areas of the science curriculum at key stage 2

	Level of confidence		
Programme of study	*A lot %*	*Some %*	*Little/none %*
Sc1	44	51	5
Sc2	67	31	1
Sc3	58	40	2
Sc4	47	47	6

Table 27a. The primary teachers' confidence in teaching Sc1*Experimental and Investigative Science* at key stage 2

	Level of confidence		
Years' teaching	*A lot %*	*Some %*	*Little/none %*
0-5 (n=289)	37	55	7
6-10 (n=138)	47	50	3
11-20 (n=174)	56	41	3
21-30 (n=221)	45	50	5
30+ (n=31)	32	68	0
All teachers	44	51	5

Table 27b. The primary teachers' confidence in teaching Sc2*Life and Living Processes* at key stage 2

	Level of confidence		
Years' teaching	*A lot %*	*Some %*	*Little/none %*
0-5 (n=289)	54	45	1
6-10 (n=138)	72	27	1
11-20 (n=174)	76	22	2
21-30 (n=221)	74	24	2
30+ (n=31)	77	23	0
All teachers	67	31	1

Table 27c. The primary teachers' confidence in teaching Sc3*Materials and their Properties* at key stage 2

	Level of confidence		
Years' teaching	*A lot %*	*Some %*	*Little/none %*
0-5 (n=289)	47	50	2
6-10 (n=138)	61	38	1
11-20 (n=174)	67	31	2
21-30 (n=221)	63	34	2
30+ (n=31)	61	36	3
All teachers	58	40	2

Table 27d. The primary teachers' confidence in teaching Sc4*Physical Processes* at key stage 2

	Level of confidence		
Years' teaching	*A lot %*	*Some %*	*Little/none %*
0-5 (n=289)	33	58	9
6-10 (n=138)	54	42	4
11-20 (n=174)	55	40	5
21-30 (n=221)	54	40	5
30+ (n=31)	39	55	6
All teachers	47	47	6

2.24 In the focus group discussions, many of the primary teachers reported feeling constrained in their teaching of science by a lack of equipment, by a shortage of adequate space for practical science activities, by a lack of time for preparing and clearing away science apparatus, and by a shortage of adult support for practical science activities.

(ii) Secondary Teachers

2.25 At key stage 3, 89% of secondary teachers reported having a lot of confidence with *Sc1 - Experimental and Investigative Science* whereas at key stage 4 the equivalent figure was 79% (Tables 28-29). For the other programmes of study of the science curriculum, confidence levels dropped even more markedly (Tables 30a-h - which show confidence levels by length of experience). For example, 81% of all secondary teachers reported feeling confident at teaching *Sc4 - Physical Processes*, at key stage 3 compared to just 50% at key stage 4 (Tables 30g/h).

Table 28. The secondary teachers' confidence about teaching the science curriculum at key stage 3 (n=576)

	Level of confidence		
Programme of study	*A lot %*	*Some %*	*Little/none %*
Sc1	89	11	<1
Sc2	80	16	2
Sc3	87	13	<1
Sc4	81	18	1

Table 29. The secondary teachers' confidence about teaching the science curriculum at key stage 4 (n=576)

	Level of confidence			
Programme of study	*A lot %*	*Some %*	*Little/none %*	*Did not teach %*
Sc1	79	17	1	1

Sc2	52	32	12	4
Sc3	60	31	5	4
Sc4	50	35	10	5

Table 30a. The secondary teachers' confidence about teaching*Sc1 Experimental and Investigative Science* at key stage 3, by experience

	Level of confidence		
Years' teaching	*A lot %*	*Some %*	*Little/none %*
0-5 (n=223)	82	17	1
6-10 (n=49)	94	6	0
11-20 (n=137)	93	7	0
21-30 (n=144)	92	8	0
30+ (n=22)	96	5	0
All teachers	89	11	<1

Table 30b. The secondary teachers' confidence about teaching*Sc1 Experimental and Investigative Science* at key stage 4, by experience

	Level of confidence		
Years' teaching	*A lot %*	*Some %*	*Little/none %*
0-5 (n=223)	72	26	1
6-10 (n=49)	80	14	4
11-20 (n=137)	88	8	2
21-30 (n=144)	81	13	0
30+ (n=22)	77	14	0
All	79	17	1

Table 30c. The secondary teachers' confidence about teaching*Sc2 Life Processes and Living Things* at key stage 3, by experience

	Level of confidence		
Years' teaching	*A lot %*	*Some %*	*Little/none %*
0-5 (n=223)	83	14	1
6-10 (n=49)	88	12	0
11-20 (n=137)	83	15	1
21-30 (n=144)	72	21	6
30+ (n=22)	73	27	0
All	80	16	2

Table 30d. The secondary teachers' confidence about teaching about teaching *Sc2 Life Processes and Living Things* at key stage 4, by experience

	Level of confidence		
Years' teaching	*A lot %*	*Some %*	*Little/none %*
0-5 (n=223)	59	25	13

6-10 (n=49)	57	31	8
11-20 (n=137)	53	37	7
21-30 (n=144)	38	40	15
30+ (n=22)	46	23	23
All teachers	52	32	12

Table 30e. The secondary teachers' confidence about teaching*Sc3 Materials and Their Properties* at key stage 3, by experience

	Level of confidence		
Years' teaching	*A lot %*	*Some %*	*Little/none %*
0-5 (n=223)	85	14	0
6-10 (n=49)	90	10	0
11-20 (n=137)	88	12	1
21-30 (n=144)	87	12	1
30+ (n=22)	86	14	0
All teachers	87	13	0

Table 30f. The secondary teachers' confidence about teaching*Sc3 Materials and Their Properties* at key stage 4, by experience

	Level of confidence		
Years' teaching	*A lot %*	*Some %*	*Little/none %*
0-5 (n=223)	57	36	5
6-10 (n=49)	70	22	4
11-20 (n=137)	64	28	5
21-30 (n=144)	57	30	6
30+ (n=22)	50	36	5
All teachers	60	31	5

Table 30g. The secondary teachers' confidence about teaching*Sc4 Physical Processes* at key stage 3, by experience

	Level of confidence		
Years' teaching	*A lot %*	*Some %*	*Little/none %*
0-5 (n=223)	75	24	<1
6-10 (n=49)	82	18	0
11-20 (n=137)	80	18	<1
21-30 (n=144)	87	10	1
30+ (n=22)	91	5	5
All teachers	81	18	1

Table 30h. The secondary teachers' confidence about teaching*Sc4 Physical Processes* at key stage 4, by experience

	Level of confidence

Years' teaching	*A lot %*	*Some %*	*Little/none %*
0-5 (n=223)	44	41	14
6-10 (n=49)	45	49	4
11-20 (n=137)	56	29	10
21-30 (n=144)	57	29	6
30+ (n=22)	50	32	9
All teachers	50	35	10

2.26 Almost all of the secondary teachers felt well prepared for some or all of the science curriculum at the start of their careers in schools (Table 31).

2.27 Those teachers with a PGCE judged themselves better prepared for teaching science than those teachers who had undertaken other modes of training (or none at all) (Table 31). Younger teachers, in particular, felt well prepared after their initial teacher education (Table 32).

Table 31. How well prepared to teach the science curriculum did secondary science teachers feel after their pre-service training?

	Proportion of the science curriculum		
Teachers' initial qualification	*All/Most aspects %*	*Some aspects %*	*Few/No aspects %*
Cert./Diploma (n=61)	39	43	15
PGCE (n=431)	50	46	3
BEd (n=40)	45	43	13
Degree+QTS (n=22)	14	55	27
None (n=13)	8	46	46
Other (n=9)	33	56	11

Table 32. How well prepared did secondary science teachers feel after their initial training (by age)?

	Age group				
Proportion of the science curriculum for which teachers felt well prepared	*21-30 %*	*31-40 %*	*41- 50 %*	*51-60 %*	*60+ %*
All/Most (n=264)	41	24	23	13	0
Some (n=265)	25	25	37	13	<1
Few/No (n=42)	7	14	50	29	0
Total	31	23	31	14	<1

C. CORRELATION BETWEEN SUBJECT QUALIFICATIONS AND CONFIDENCE LEVELS

2.28 An examination of the correlations between subject knowledge and subject qualifications revealed that those with higher qualifications in biology tended to have

higher qualifications in chemistry, but not physics, while those with high qualifications in chemistry tended to have higher qualifications in physics. This simply suggests that the science teaching community is split between biologists and physical scientists.

2.29 As for connections between the science teachers' subject qualifications and their levels of confidence in teaching science, an analysis of the responses for all teachers and for teachers with 0-5 years' experience) showed that:

a) Higher level biology qualifications were not associated with confidence in teaching biology at KS3 (r = 0.01) for inexperienced teachers but were positively associated for all teachers (r = 0.14). Higher level biology qualifications were positively associated with confidence in teaching the subject at KS4 for both groups (r = 0.23 (inexperienced)/0.24 (all)). They were negatively associated with confidence in teaching physics at KS4 (r = -0.21/-0.10).

b) A higher level of chemistry qualification was positively associated with confidence in teaching chemistry at KS3 (0.21 (inexperienced)/0.24 (all)) and at KS4 (r=0.20/0.24).

c) A higher level qualification in teaching physics was correlated with a lack of confidence in teaching biology both at KS3 (r = -0.24 (inexperienced)/-0.19 (all)) and KS4 (r = -0.33/-0.17); had little correlation with the teaching of chemistry (KS3: r = 0.0/-0.03, KS4: r = -0.10/0.02); and had a positive correlation with confidence in teaching physics at KS3 (r = 0.22/0.18) and at KS4 (r = 0.27/0.24).

D. THE TEACHERS' REQUIREMENTS REGARDING INSET AND THEIR CPD

2.30 In the focus group discussions, teachers were clear about improvements in INSET that they would like to see made.

2.31 More than anything else, they wanted realistic ideas about how to teach particular topics as well as materials to support their teaching. They were firmly of the view that effective INSET usually involved some or all of the following:

- an opportunity to share experiences with colleagues from other schools;
- a focus on teacher needs;
- practical activity rather than pure theory:
- interaction rather than simply listening;
- top quality input from tutors with relevant classroom experience: and
- the opportunity to try out new methods and materials in their own classrooms between sessions.

2.32 They also wanted the opportunity to share experiences and good practice with colleagues in their own school, and in other schools. The teachers wanted more opportunities to compare their own practice with that of other teachers as a way of identifying their professional development needs.

2.33 The primary teachers, particularly those with less experience, and inexperienced secondary science teachers, wanted courses dealing with ideas for practically based investigative work and with the organisation and administration of practical work, coping with large classes and with a wide range of ability.

2.34 The more experienced teachers attached particular value to the 10 and 20 day courses which they had attended in the past. They judged the main benefits of such extended courses as the provision of rich sources of materials, time for reflection, and opportunities to share views and experience with teachers from other schools.

2.35 For the teachers taking part in the focus group discussions, constraints of time and pressure of other work were seen as the main problems in terms of their personal CPD.

E. THE TEACHERS' INSET DURING 1998/99

2.36 Most teachers had received some formal INSET during the year, with over half having undertaken ICT INSET (Table 33).

Table 33. The INSET that the primary and secondary teachers of science received in 1998/9

	Sector	
	Primary (n=854)	*Secondary (n=576)*
Topic	**%**	**%**
Preparation for senior management	15	10
Preparation for middle management	8	18
ICT	59	53
Class management	24	30
Teaching skills	30	37
Subject knowledge	23	15
Assessment	53	44
Mentoring	18	19

2.37 The main sources of INSET were the teachers' colleagues in schools (primary, 85%; secondary, 86%), compared with out of school sources (primary, 58%; secondary 68%) (Table 34).

Table 34. The location in which the primary teachers and secondary teachers received their science INSET in 1998/9

	Primary (n=854)	*Secondary (n=576)*

Source	%	%
In school, from colleagues	85	86
In school, from outsiders	51	67
Out of school	58	68

2.38 Teachers in the focus group discussions generally reported attending far less formal science INSET than previously, and far less sustained training in particular (e.g. 20-day courses). Data from the questionnaire survey also supports the point made in the focus group discussions that inexperienced and experienced teachers receive similar levels of INSET (Tables 35-36).

2.39 Dissatisfaction with the use made of the five training days available each year (out of 195 working days in teachers' contracts) was widespread. In the group discussions, many teachers reported that the training days tended to focus more on institution-wide priorities rather than on subject-based work and, then, more on administration than on teaching.

Table 35. The percentage of primary teachers who had attended INSET courses in the past year

	Teachers with 0-5 years' experience (n=289) %	*Teachers with more than 5 years' experience (n=564) %*
In school, by colleagues	83	86
In school, by other staff	63	71
Out of school	72	82

Table 36. The percentage of secondary teachers who had attended INSET courses in the past year

	Teachers with 0-5 years' experience (n=223) %	*Teachers with more than 5 years' experience (n=344) %*
In school, by colleagues	88	86
In school, by other staff	66	69
Out of school	66	71

F. THE TEACHERS' ASSESSMENT OF THEIR INSET

2.40 Although few teachers regarded their INSET courses as 'rarely useful', levels of satisfaction varied considerably for different topics (Tables 37a/b). Courses that addressed improving teaching skills and subject knowledge were generally rated more highly than other topics. Teacher evaluations were lowest for courses on Information and Communications Technology (ICT), class management and assessment (Tables 37a/b).

Table 37a. The primary teachers' evaluations of the INSET that they received during 1998/9

Topic	*Generally useful %*	*Sometimes useful %*	*Rarely useful %*
Preparation for senior management (n=127)	64	35	0
Preparation for middle management (n=72)	54	43	0
ICT (n=507)	54	38	6
Class management (n=201)	44	45	5
Teaching skills (n=255)	66	30	2
Subject knowledge (n=193)	65	29	2
Assessment (n=454)	50	43	3
Mentoring (n=150)	55	39	5

Table 37b. The secondary teachers' evaluations of the INSET that they received during 1998/9

Topic	*Generally useful %*	*Sometimes useful %*	*Rarely useful %*
Preparation for senior management (n=57)	58	40	2
Preparation for middle management (n=104)	57	39	4
ICT (n=308)	41	50	8
Class management (n=171)	37	58	5
Teaching skills (n=215)	53	42	3
Subject knowledge (n=86)	57	38	2
Assessment (n=251)	45	49	2
Mentoring (n=111)	50	42	7

2.41 The secondary teachers rated the INSET that they received away from school as more useful than INSET given by colleagues in school (Table 38b). Primary teachers were more positive than the secondary teachers about the INSET they received in school from colleagues (Table 38a).

Table 38a. The primary teachers' opinions about their science INSET in 1998/9

Source	*Mostly useful %*	*Some use %*	*Little use %*
In school, from colleagues (n=724)	61	35	2
In school, from outsiders (n=568)	54	43	3
Out of school (n=658)	56	42	2

Table 38b. The secondary teachers' opinions about their science INSET in 1998/9

Source	*Mostly useful %*	*Some use %*	*Little use %*
In school, from colleagues (n=493)	37	56	7
In school, from outsiders (n=385)	29	57	15
Out of school (n=392)	53	42	4

2.42 In the focus groups:

(a) Many teachers felt that INSET courses were not always adequate to meet their needs. They reported that it was difficult to judge the potential of an INSET course from the information that was made available to them by providers.

(b) The primary teachers reported that, partly because of funding constraints, professional development, in the form of attendance on short training courses, tended to be undertaken mainly by science co-ordinators, of which there was usually one in

each school. In many cases, teachers were unable to benefit adequately from the system of 'cascading' knowledge from their co-ordinator because of a lack of time, or because the co-ordinators lacked the skills to train other teachers.

(c) Both primary and secondary teachers reported that opportunities to build on their initial training were very limited. They had been trained in their initial teacher education for a range of topics but not for all areas of the science curriculum and so needed more training.

(d) The teachers also reported that a lack of funding, lack of availability of local providers and the inappropriate timing of courses all mitigated against teacher participation in subject-focused INSET.

(e) Both primary and secondary teachers reported that appraisal arrangements were widely seen as inadequate for addressing their paramount need to identify their own strengths and weaknesses. Teachers felt that they needed to have more say in their personal professional development particularly in the selection of courses that they attended.

(f) More generally, the teachers were unclear about how they could develop personally and professionally throughout their careers. They were unable to identify or access anything resembling a teacher-friendly system for their continuous, personal professional development. Some teachers spoke highly of the videotaped lessons distributed as part of the national numeracy and literacy initiatives in primary schools. In contrast, there is a paucity of useful videotaped lessons showing good practice in science teaching.

G. THE TEACHERS' VIEWS ABOUT ADVICE AND SUPPORT FROM 3RD PARTIES

2.43 Teachers' sources of *advice*, as opposed to formal INSET, were mainly other teachers, LEA advisors, teachers' centres and, in the case of secondary teachers, the Association for Science Education (Table 39).

2.44 Of those who had heard of the main professional organisation, the Association for Science Education (ASE), levels of satisfaction varied from 82% 'satisfactory' or 'good' (primary teachers) to 90% (secondary teachers) (Tables 40a/b). However, 26% of the primary teachers had not heard of the ASE (Table 45a). Secondary teachers who had attended one or more of the ASE's Annual Meetings, held in January at different locations throughout the country, generally expressed high levels of satisfaction with them.

2.45 Their levels of satisfaction were generally on the low side. For instance, 24% of the primary teachers and 31% of the secondary teachers rated the help that they received from LEA advisors as 'poor'; and 31% of the primary teachers and 42% of the secondary teachers rated the help that they received from teachers' centres as 'poor' (Tables 40a/b).

Table 39. The sources of science advice used by the primary and secondary teachers in 1998/9 (n=576)

Source	Primary (n=854) %	Secondary (n=576) %
Other teachers	79	92
LEA advisors	49	51
Teachers' Centre	40	25
ASE	39	56

Table 40a. The primary teachers' opinions about the quality of science advice received from various sources

Source	Good %	Satisfactory %	Poor %
Other teacher (n=675)	59	37	4
LEA advisors (n=421)	33	43	24
Teachers' Centres (n=338)	21	48	31
ASE (n=335)	32	50	18

Table 40b. The secondary teachers' opinions about the quality of science advice received from various sources

Source	Good %	Satisfactory %	Poor %
Other teacher (n=529)	70	27	3
LEA advisors (n=292)	26	43	31
Teachers' Centres (n=146)	7	51	42
ASE (n=324)	36	54	10

Table 41. The secondary teacher's opinions about the quality of advice offered by the ASE in schools in different types of location

Area	Good %	Satisfactory %	Poor %
Urban (n=96)	40	49	11
Suburban (n=159)	33	59	8
Rural (n=62)	42	50	8

2.46 Less than a third of teachers in primary schools with 100 pupils or less considered the advice that they had received from their colleagues was good and over a quarter had not received any help from their colleagues at all during the year (Table 42).

Table 42. Primary teachers' opinions about the help that they received from their colleagues, by size of school

Source	Good %	Satisfactory %	Poor %	Not received %
0-100 (n=103)	32	36	4	27
101-500 (n=718)	48	28	3	18
501-1000 (n=29)	48	35	3	14
1000+(n=4)	75	0	0	25

2.47 In the focus groups, experienced teachers reported feeling less able now than in previous years to benefit from the advice of inspectors or advisors from the local education authority. Teachers reported that there was a general feeling that local authority staff were more stretched than in previous years.

2.48 Teachers in urban schools were more critical of the advice that they had received from LEA advisors than were teachers in suburban and rural schools (Tables 43-44). Reasons for the dissatisfaction raised in the focus group discussions included a shift in the focus of advisors' work from the provision of advice to inspecting schools, thus making them less accessible.

Table 43a. Primary teachers' opinions about the quality of advice offered by LEA advisors in different types of location

Area	Good %	Satisfactory %	Poor %
Urban (n=136)	38	35	27
Suburban (n=154)	30	45	25
Rural (n=123)	33	49	19

Table 43b. Secondary teachers' opinions about the quality of advice offered by LEA advisors in different types of location

Area	Good %	Satisfactory %	Poor %
Urban (n=105)	18	42	40
Suburban (n=121)	31	44	26
Rural (n=60)	28	50	22

Table 44a. Primary teachers' opinions about the quality of advice offered by teachers' centres in different types of location

Area	Good %	Satisfactory %	Poor %
Urban (n=124)	24	43	33
Suburban (n=117)	18	50	32
Rural (n=91)	19	52	30

Table 44b. Secondary teachers' opinions about the quality of advice offered by teachers' centres in different types of location

Area	Good %	Satisfactory %	Poor %
Urban (n=48)	2	50	48
Suburban (n=71)	10	54	36
Rural (n=24)	4	42	54

2.49 Although teachers reported using a variety of sources of information in their lessons, they used third party resources infrequently (Tables 45-46). In focus group discussions, teachers pointed out that whilst a lot of effort and funding went into the production of materials, too little went into supporting training for its use.

Table 45a. The sources of 3rd party materials used by primary teachers and their frequency of use (n=854)

Source	Frequently %	Occasionally %	Never %	Not aware of resources %
Industry	2	32	45	20
Societies	1	11	55	32
Government agencies	<1	12	52	34
Charities	<1	19	41	39
Museums	8	63	23	5
SETNET	<1	4	22	73
ASE	7	28	39	26

Table 45b. The sources of 3rd party materials used by secondary teachers of science and their frequency of use (n=576)

Source	Frequently %	Occasionally %	Never %	Not aware of resources %
Industry	4	50	37	9
Societies	8	50	38	4
Government agencies	1	31	51	17
Charities	1	27	40	31
Museums	2	41	49	7
SETNET	1	11	32	56
ASE	10	45	39	6

Table 46a. The sources of information used by primary teachers of science (n=854)

Source	Often %	Occasionally %	Rarely %
Textbooks	43	36	21
Other books	61	35	4
Videos	26	54	19
CD ROMS	14	52	34
Periodicals	16	46	37
Courses	16	51	32
Colleagues	25	54	21

Table 46b. The sources of information used by primary teachers of science with 0-5 years experience (n=289)

Source	Often %	Occasionally %	Rarely %
Textbooks	41	36	24
Other books	58	38	4
Videos	23	53	24
CD ROMS	14	50	37
Periodicals	15	41	44
Courses	13	45	42
Colleagues	30	56	15

Table 46c. The sources of information used by secondary teachers of science (n=576)

Source	Often %	Occasionally %	Rarely %
Textbooks	89	10	1
Other books	46	46	7
Videos	51	45	4
CD ROMS	15	51	34
Periodicals	11	36	53
Courses	7	52	41

Colleagues	39	51	10

Table 46d. The sources of information used by secondary teachers of science with 0-5 years' experience (n=223)

Source	Often %	Occasionally %	Rarely %
Textbooks	92	8	1
Other books	55	40	5
Videos	50	47	3
CD ROMS	19	44	38
Periodicals	9	27	64
Courses	7	50	43
Colleagues	43	50	7

2.50 During the focus group discussions, reasons emerged as to why so many schools and teachers did not make fuller use of the third party support that is available. Many teachers pointed out that third party materials sometimes failed to be relevant to the new versions of the National Curriculum. Secondly, there was a plethora of materials and not enough time to identify what was useful. Thirdly, teachers reported that independent sources of advice on the value and effectiveness of third party materials were less available than in the past.

2.51 The teachers reported that existing third party materials did not satisfy many of their needs. This was partly due to a lack of training in the use of the materials produced by third parties.

Table 47a. Resources that primary teachers of science would like more of

Source	Yes %	Possibly %	No %
Tours of scientific establishments	16	47	38
Ideas for science investigations	89	9	2
Teaching material about social and ethical issues of science	47	42	10
Other material	88	11	1
Courses for pupils	47	39	15
Courses for teachers	81	17	2

Table 47b. Resources that secondary teachers of science would like more of

Source	Yes %	Possibly %	No %
Tours of scientific establishments	44	45	11
Ideas for science investigations	87	12	1
Teaching material about social and ethical issues of science	61	33	6
Other material	83	16	1
Courses for pupils	58	36	6
Courses for teachers	78	21	1

2.52 The major concern of both primary and secondary teachers with less than five years' experience was the lack of support that they reported receiving during their first few years in the profession. In some LEAs, some teachers reported good levels of support in their first year of teaching whereas others reported very little initial support. Teachers who had received good initial support generally found that it was rarely sustained beyond the first year of teaching.

2.53 Reactions to the proposals in the Government's Green Paper, entitled "Teachers: meeting the challenge for change" (*Cmn 4164, December 1998*), were mixed. For example, several teachers felt that the Advanced Skills Teacher (AST) status would keep good teachers in the classroom. The experienced teachers were more wary and suggested that the scheme might actually take good teachers out of their own classrooms and schools, without adequate resources being made available for their replacement.

2.54 Teachers mentioned examples of successful teacher-industry partnerships which exist around the country. Successful partnerships involved activities such as teacher placements in industry, the production of classroom materials and visits to schools by practising scientists.

(i) Use of Information and Communication Technology

2.55 An aspect of the science curriculum that has received significant funding for resources and training has been Information and Communications Technology. However, despite the investment, the frequency of use of computers in science was remarkably low.

2.56 The National Grid for Learning was used only 'rarely' by 71% of primary teachers and 72% of secondary teachers of science (Tables 48a/c). The corresponding figures for teachers with 0-5 years' experience were 74% of primary teachers and 75% of secondary teachers of science (Table 48b/d). Teachers in the focus groups did not report finding the NGfL particularly useful for the teaching of science.

2.57 Only 9% of secondary teachers reported that they used computers 'often' in science lessons, 65% used computers 'occasionally' and 26% used them 'rarely' (Table 48c). The corresponding figures for secondary teachers with 0-5 years' experience were 12% 'often', 57% 'occasionally' and 31% 'rarely' (Table 48d). The figures for primary teachers were more encouraging – 42% of teachers reported using computers 'often' in their teaching (Table 48a). The corresponding figure for primary teachers with 0-5 years' experience was 44% (Table 48b).

2.58 65% of secondary science teachers used computers 'often' for preparing materials and 62% used them 'often' for administration Table 48c). The figures for primary teachers (43% use computers for preparing materials 'often' and 35% use them 'often' for administration) were lower because of limited resources and less non-contact time in primary schools (Table 48a).

Table 48a. Teachers' use of computers in primary science (n=854)

Use	Often %	Occasionally %	Rarely %
Preparing materials	43	41	16
Administration	35	33	32
Teaching	42	50	8
National Grid for Learning	6	23	71
Internet	11	33	56
Email	16	24	60

Table 48b. Teachers with 0-5 years experience use of computers in primary science (n=289)

Use	Often %	Occasionally %	Rarely %
Preparing materials	49	39	13
Administration	35	36	29
Teaching	44	47	9
National Grid for Learning	6	20	74
Internet	13	35	52
Email	18	23	59

Table 48c. Teachers' use of computers in secondary science (n=576)

Use	Often %	Occasionally %	Rarely %
Preparing materials	65	27	8
Administration	62	26	12
Teaching	9	65	26
National Grid for Learning	3	25	72
Internet	21	43	36
Email	29	26	45

Table 48d. Teachers with 0-5 years experience use of computers in secondary science (n=223)

Use	Often %	Occasionally %	Rarely %
Preparing materials	65	31	4
Administration	50	34	16
Teaching	12	57	31
National Grid for Learning	4	21	75
Internet	23	44	32
Email	35	23	41

2.59 The major constraint on teachers' use of ICT was reported as lack of time (88% of primary teachers and 86% of secondary teachers) (Table 49a). The next most

important factor reported was 'know-how' for primary teachers (56%) and access to equipment for secondary teachers (65%). Figures for teachers with 0-5 years' experience were broadly similar (Table 49b).

Table 49a. Constraints on teachers' use of ICT

	Primary n=854	**Secondary n=576**
Constraint	***%***	***%***
Know how	56	37
School access	42	18
Equip access	40	65
Time	88	86
Help	48	38
Cost	29	28

Table 49b. Constraints on teachers with 0-5 years' experience use of ICT

	Primary n=854	**Secondary n=576**
Constraint	***%***	***%***
Know how	47	22
School access	42	17
Equip access	43	60
Time	88	83
Help	43	26
Cost	27	26

IV. CONCLUSIONS AND ACKNOWLEDGEMENTS

2.60 We believe that these results provide the Council with a sufficiently robust picture, from the teachers' viewpoint, of the general situation that exists at present in primary and secondary schools in England.

2.61 The response rate to our survey was good considering the short timescale available for schools to complete and return the questionnaires before the commencement of the summer holidays, and comparable to return rates for other questionnaire samples. The sample size is sufficient to ensure that the results are accurate to plus or minus 2.5%. Further, the results certainly accord with our own day-to-day experience in training and developing science teachers and working with schools on science education matters. Nor are we aware of any existing body of research that conflicts with them in any material ways.

2.62 In the light of the research findings, we believe that the main issues arising for the Council's further consideration are:

a) the urgent need to examine carefully the effectiveness of the current provision for *personal professional development* of teachers of science. In particular, more time

and funding needs to be allocated to personal, professional training rather than institutional imperatives.

b) the dissatisfaction felt by teachers of science about the way in which their needs are determined, and the effects of this dissatisfaction on teacher morale and commitment;
c) teachers' desire for a planned, sustained and effectively monitored system of personal professional development;
d) the negative impact on teacher development of poor quality, short-term INSET which does not meet teachers' needs;
e) the lack of impact of much of the third party sponsored material on teaching and learning.

2.63 More particularly, we believe that there needs to be a major, cultural shift within the profession to make subject-specific, classroom-based continuous professional development the norm. Such a cultural shift requires raising the significance of CPD, and ensuring that a proper systematic account is maintained and managed for all individuals during their career. At present, for a significant number of newly qualified teachers of science, if not the great majority, their individual needs for subject-based CPD take second place to whole school issues such as the current initiatives in primary schools for raising literacy and numeracy, and any support they do receive diminishes rapidly after the first year of their careers.

2.64 More systematic, high quality provision is badly needed, and would contribute hugely to raising school standards and effectiveness in terms of the science education pupils receive during their compulsory schooling. Meta-analysis in the US[1] shows that noticeable improvements in the classroom depended on CPD being long term, classroom focused and supported by coaching from an experienced practitioner. Other researchers argue that effective CPD recognises personal, social and professional development rather than simply skills and knowledge training[2].

2.65 Simply expressed, by the end of the first five years of their careers, all teachers of science should be well on the way to developing the necessary skills and competences that they require to become lifelong learners within the profession of teaching. They also need a top quality system, with suitable CPD products, services and support. The teachers should be working within a school context that has the capacity and ability to handle CPD including staff appraisal, mentoring and advice to far higher standards than presently exist.

2.66 In this latter regard, school management issues are vitally important considerations. In particular, managers have a responsibility for the creation and maintenance of a pro-CPD culture in a school. Management should have the capability to sustain and nurture the subject-related expertise of its teaching staff effectively within the existing very real constraints on science teachers' CPD which the study has highlighted, namely the provision of time and funding, an appropriate reduction in

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[1] Joyce, B. and Showers, B. (1995) *Student Achievement Through Staff Development: Fundamentals of School Renewal*. London: Longman Publishing Group.
[2] Bell, B. & Gilbert, J. (1995) *Teacher Development: A Model from Science Education*. London: Falmer.

workload and fatigue, and the necessary supply cover for teachers to attend external courses.

2.67 The high level of investment in the NGfL and ICT in schools has not taken sufficient consideration of the inadequate provision of hardware and software in schools, nor the time required to become a proficient and competent user of ICT, both for personal professional use and as a pedagogic tool. Similar considerations apply to the curricula support material and other support resources provided by the numerous third party sponsors of school science.

2.68 In closing, we would like to thank, firstly, all those teachers and headteachers who took time to fill in the questionnaires and to attend the focus group discussions. We hope that we have been able to capture the wealth of ideas and enthusiasm that we found for science education in schools, and that in distilling the data to manageable proportions, we have not misrepresented points of view nor ignored what was said to us.

2.69 Secondly, we have appreciated the assistance given to us by a range of individuals, including inspectors and advisors, with the setting up of the focus group discussions.

2.70 Third, we would like to thank Janet Fairbrother for her assistance in organising the focus groups and other aspects of the data collection and interpretation.

2.71 Fourth, we have benefited greatly from the support and guidance offered by the Steering Group particularly Professor Philip Adey, Dr Rod Watson and Anne Goldsworthy.

2.72 Finally, we would like to thank Steve Elton, the Secretary to the Council for Science and Technology for his advice and guidance throughout the project.

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ANNEX 1: GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ASE	Association for Science Education
CPD	Continuous Professional Development
FTE	Full Time Equivalent (staff)
GTC	General Teaching Council
INSET	In-service Education and Training
ITC	Information and Communication Technology
KS2	Key Stage 2 (Years 4-6) of the National Curriculum
KS3	Key Stage 3 (Years 7-9) of the National Curriculum
KS4	Key Stage 4 (Years 10-11) of the National Curriculum
LEA	Local Education Authority
NGfL	National Grid for Learning
PGCE	Postgraduate Certificate in Education
QTS	Qualified Teacher Status
SETNET	Science, Engineering, Technology, Mathematics Network
TTA	Teacher Training Agency

ANNEX 2: SURVEY METHODOLOGY AND QUESTIONNAIRES

A1. The survey took the form of a questionnaire survey of 2716 primary and secondary schools and 20 focus groups involving more than 150 teachers from 50 schools in five regions of England. A set of questionnaires was sent to a randomly selected sample of 1977 primary and 739 secondary state schools. Three questionnaires were sent to each school – one for the headteacher, one for a teacher of science with less than five years' experience and one for an experienced teacher of science, preferably with more than 10 years' experience.

The Questionnaire Survey

A2. After trials with groups of primary and secondary teachers, two copies of an 8 page questionnaires for teachers, and a shorter questionnaire for headteachers were produced. These are reproduced below and were sent to the sample of schools by the National Foundation for Educational Research (NFER) in June 1999. Reminder letters were sent to non-replying schools on two occasions.

A3. Data from returned questionnaires were entered into a computer database. The accuracy of the data entry procedure was established by cross-checking a 10% sample across all coders. Open responses were coded using a scheme developed from the data.

The Focus Groups

A4. Four focus group discussions (2 primary and 2 secondary) with teachers were held in each of five areas of the country (the Southwest (Okehampton and Exeter), South East/London (Bromley, Croydon, Central London, Sutton and Surrey), Birmingham/West Midlands (Solihull and Worcester), East Anglia (Norwich), North/North-East (Sheffield and Hull)). Teachers were identified by various means, including recommendation from local authority personnel. Teachers were paid an honorarium for attending.

A5. Each focus group lasted an hour and a half and was organised around a standard set of statements about issues identified by the research team and the Project Steering Group. The focus group discussions were tape-recorded and the data used to identify significant themes emerging from the responses.

A6. Summaries of each focus group were written and the data for each cohort (primary less experienced, primary more experienced, secondary less experienced and secondary more experienced) were aggregated.

Analysis and Presentation of the Report

A7. Where relevant, meaningful distinctions were drawn between:

(a) the various types of schools and their differing circumstances; for instance in terms of their size, pupil profile, and location in rural, suburban and urban areas;
(b) subject leaders (heads of science), experienced teachers and teachers still in the early stages of their professional lives after obtaining 'qualified teacher status';
(c) the subject qualifications of these science teachers and the level/nature of these qualifications;
(d) the proportion of time that teachers spend teaching science subjects to pupils that fall within (and outside) their area of expertise; and,
(e) the support and assistance provided by Local Education Authorities (LEAs) compared to other sources.

A9. Individual schools were not identified during the analysis and, therefore, information about the examination, assessment and inspection results of the schools concerned was not used.

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