Laboratories, Resources and Budgets

A report for the Royal Society of Chemistry on Provision for Science in Secondary Schools

CLEAPSS

RS•C
advancing the chemical sciences

April 2004

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The CLEAPSS® School Science Service is an advisory service supporting **practical** science (and technology) in schools, colleges, etc. It is largely funded by subscriptions from members. At the present moment every one of the 180 education authorities in England, Wales, Northern Ireland and the various islands is a member and hence all their schools have free access to CLEAPSS services. (A sister organisation, SSERC, operates in Scotland). The vast majority of independent schools, post-16 colleges and teacher-training establishments are associate members, as are many curriculum developers, field study centres, hands-on museums and learned societies. There is a particular focus on health and safety.

CLEAPSS produces a large number of publications for members, ranging from termly newsletters for primary and secondary schools, a 1000-page *Laboratory Handbook*, *Hazcards®*, *Recipe Cards* and many leaflets and booklets. Much of this is now available on CD-ROMs. The members' *Helpline* takes about 6600 calls per year. CLEAPSS also runs about 180 courses per year, mostly 1-day. We are represented on several committees of the British Standards Institution and maintain a close dialogue with the Health and Safety Executive, the Qualifications and Curriculum Authority, professional bodies and others with an interest in science education.

Dr Peter Borrows *(Director)*

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Executive Summary of a Report for the Royal Society of Chemistry on Provision for Science in Secondary Schools

Despite the UK's excellent record in international comparisons in school science, the Royal Society of Chemistry was concerned that a lack of good laboratory facilities and sufficient modern equipment in schools may be discouraging young people from pursuing the study of science and may also discourage graduates from taking up a career in teaching. It asked CLEAPSS to obtain base line data on the standards of science laboratories and resources and the levels of budgets, to help it make a case for improvement, if necessary, and to estimate the costs of effecting significant improvements. (Of course, there may be further reasons for low take-up and these were to be investigated in other projects not involving CLEAPSS.) The work was divided into two projects. The brief was to determine:

(a) the number of laboratories that are not up to date, according to an agreed set of standards, the costs of refurbishment to an appropriately high standard and thus the overall cost of bringing all school laboratories up to a modern standard; and

(b) the annual cost of providing apparatus, resources and chemicals that is needed per pupil to provide an effective science education and its relationship to actual provision.

Questionnaires were sent to **every maintained secondary school in England**. The decision to avoid schools in the devolved administrations was taken by the RSC although the results would almost certainly be similar. No questionnaires were sent to post-16 colleges or independent schools. Half the schools in each of the 148 LEAs in England were sent a questionnaire relating to laboratories, the other half received one relating to resources and budgets. There was a response rate of 42% on laboratories, and 26% on resources, phenomenally high levels of return for surveys of this type, giving very high confidence in the results.

For the Laboratory Project a small number of LEA science advisers were asked to estimate the quality of laboratories in their LEAs, with high levels of agreement between their figures and those of their schools. There were also discussions with a number of manufacturers about the cost of new build and refurbishment. DfES publications were also consulted.

For the Resources Project, permission was obtained from the Royal Society to use their 1997 report *Science Teaching Resources: 11-16 year olds* as a starting point. The lists were reviewed in the light of curriculum and other changes and re-costed, with some help from Philip Harris Ltd. In addition, the costs of post-16 work were incorporated. This was done by analysing, for each of the main sciences, one leading examination specification, which has well-developed materials and resources clearly identified.

Results were analysed by type of school, under a number of criteria: community, foundation, etc; age range of pupils; selective or not; specialist school status. LEAs were also classified as high-, medium- and low-spending based on the average pupil funding per head for 2001-2. The 148 education authorities in England were divided into three groups of 49 or 50, depending on where they were in the rank order. Note, however, that the low-spending LEAs tend to be shire counties and thus have more schools than the high-spending ones, which tend to be relatively small metropolitan authorities or London Boroughs.

Summary of the Laboratory Project Report

Only a brief summary is provided here. More details will be fund in the main report. The table shows how the laboratories in the sample were classified and estimates the total number of each type in maintained secondary schools in England.

Laboratories	*Number in sample*	*% in sample*	*Number estimated for all maintained schools in England*
Excellent	280	5%	1 315
Good	1 641	30%	7 770
Basic (uninspiring)	2 262	41%	10 695
Unsafe / unsatisfactory	1 386	25%	6 560
TOTAL	5 569	100%	26 340

At the same time, teachers report that they need one additional laboratory per school, on average, to be able to teach all science lessons in a laboratory; that is, an under-provision of at least 3 518 laboratories. Put another way, these statistics show that when pupils are in a science laboratory, their experience is **unsafe, unsatisfactory or uninspiring for 65% of the time**. This does not include the **13% of the time that they are not in a laboratory at all**.

In the preparation areas that support science teaching, 36% are described as good or excellent, with 21% described as poor. Similar percentages describe the storage and preparation space available to science technicians. However, the design of departments has generally meant that prep rooms are easily accessible to the laboratories that they serve, with 65% of responses showing accessibility as either good or excellent.

The total cost of improving laboratory standards obviously depends not only on assumptions about the number of laboratories needed and their existing quality but also about the cost of new build and refurbishment. If all the issues were addressed at once, and upgrading was to a good (as opposed to an excellent) standard, a conservative estimate of the **total finance needed would be around £1 380 000 000**. The components of this total are as follows.

Upgrade all unsafe / unsatisfactory laboratories to a good standard	£361 000 000
Upgrade all basic laboratories to a good standard	£321 000 000
Build sufficient new laboratories	£510 000 000
Provide sufficient fume cupboards	£41 000 000
Upgrade all preparation areas to a good standard	£89 000 000
Extend preparation areas	£24 000 000
Provide sufficient dishwashers	£6 000 000
Minimum cost of lift provision	£28 000 000
TOTAL	**£1 380 000 000**

Summary of the Resources Project Report

As before, for more details, refer to the main report. The table shows the sum of money (to the nearest pound) available to science departments, and the amount per pupil, in maintained secondary schools in England in the current and previous years.

	Average sum total	Range in total sum		Average per pupil	Range in sum per pupil	
Current financial year allocation (2003 – 4)						
All schools	£10 560	£1 030	£40 000	**£9.89**	£0.64	£71.43
Last financial year allocation (2002 – 3)						
All schools	£10 483	£1030	£47 000	**£9.83**	£0.64	£51.65

The £9.89 average is only a little more than the £9.40 reported in a survey in 1998 and has not kept pace with inflation. The average for each pupil in 11-16 schools is **£8.78 per year** and **£10.66** in 11-18 schools. Of course this reflects the much greater cost of advanced science courses. These figures are well below the cost per pupil as estimated below especially bearing in mind that in most schools this sum has to cover the cost of text books and photocopying, etc. There is also a surprisingly wide range in this sum. Over 90% of schools responding judged that their funding was inadequate to sustain an effective level of science education. Shortfalls were so severe that, in some cases, comments showed that schools were not able to meet fully the requirements of the National Curriculum (especially in ICT) and practical work was being cut down.

The estimated cost, per pupil, of providing equipment (including depreciation), chemicals and biological materials is shown below, with the figures from the Royal Society 1997 report included for comparison. Both the original and current reports include an 'essential' list of resources and a 'desirable' list. The latter includes items which more fortunate schools use to teach science more effectively. Often these are items which are essential for post-16 work but can enhance the curriculum in KS3 and 4. Unlike the original report, we compare the costs of different class sizes. Some costs are fixed, independent of the size of the class (mostly items that teachers demonstrate), others depend on the number of pupils, eg a large class needs more microscopes.

Annual cost per pupil, 11-16	*Classes of 24 pupils*		*Classes of 30 pupils*	
	Essential only	*Essential + desirable*	*Essential only*	*Essential + desirable*
1997 Royal Society report	£11.38	£17.28	-	-
This report	£20.58	£29.14	£22.22	£30.75
Shortfall based on survey findings	£11.80	£20.36	£13.44	£21.97

These figures do not include costs of text books, photocopying, etc. Much of the increased cost can be attributed to the current emphasis on ICT but equipment and chemicals costs have risen faster than inflation.

As there are just under 3 million pupils in English secondary schools in the 11-16 age range, it follows that, in round figures, if half of them are taught in classes of 24 and the remainder in classes of 30, science departments need about a further £37 million per year to provide a reasonable level of resources for teaching science, ie **about £10 000 more per science department.**

It is less easy to provide an accurate figure for the cost of providing resources for advanced science courses. Sixth-form numbers vary enormously, as does the relative uptake of the different science subjects. For this exercise, we have assumed one group of 20 pupils in each of AS biology, chemistry and physics and a further group of 16 in A2 in each subject, in all 108 pupil-subjects. Further research would be needed to come up with more accurate figures but making various assumptions, we estimate that the average school spends **£28.45 per pupil per year per advanced science subject studied**. However, the costs depend on which science subjects are studied.

	Cost per pupil per year averaged over two years ESSENTIAL ITEMS ONLY	Cost per pupil per year averaged over two years ESSENTIAL + DESIRABLE ITEMS
Biology	£34.82	£43.83
Chemistry	£93.78	£93.78
Physics	£296.82	£436.91

It is clear that the actual cost of even just essential items is far greater than the average amount allocated. The shortfall varies between £6 per pupil per year in biology and £270 in physics. It is possible that the discrepancy in physics is one cause of the relative unpopularity of physics as a degree subject and of the well-known shortage of physics teachers.

Whilst there might be arguments about the details, both pre- and post-16, it seems inescapable that a very substantial amount is needed to upgrade the quality of school science resources. Moreover, this would not be a one-off cash injection but a continuing commitment to maintain a minimum standard of provision. Unless science is taught in an up-to-date manner, using modern equipment, there is little likelihood that young people will be motivated to continue their study of science. For those who do, there is even less likelihood that they will want to return to schools, as teachers.

Laboratories, Resources and Budgets

A Report for the Royal Society of Chemistry on Provision for Science in Secondary Schools

1 The scope of this report

1.1 Introduction

1.1.1 The reason for this report

The Education Manager (Schools and Colleges) of the Royal Society of Chemistry (RSC) approached the CLEAPSS® School Science Service in the summer of 2003. The UK has an excellent record in international comparisons in school science. Despite this and existing government investment in education, the RSC was concerned that a lack of good laboratory facilities and sufficient modern equipment in schools may be discouraging young people from pursuing the study of science and may also discourage graduates from taking up a career in teaching. It asked CLEAPSS to obtain base line data on the standards of science laboratories and resources and the levels of budgets to help it make a case for improvement, if necessary, and to estimate the costs of effecting significant improvements. (Of course, there may be further reasons for low take-up and these were to be investigated in other projects not involving CLEAPSS.)

1.1.2 Methodology

CLEAPSS accepted the commission and divided the work into two projects, each with its own project officer, appointed on a consultancy basis. The brief was to determine:

(a) the number of laboratories that are not up to date, according to an agreed set of standards, the costs of refurbishment to an appropriately high standard and thus the overall cost of bringing all school laboratories up to a modern standard ("the Lab Project"); and

(b) the annual cost of providing apparatus, resources and chemicals that is needed per pupil to provide an effective science education and its relationship to actual provision ("the Resources Project").

Andy Piggott, an experienced science education consultant, was appointed to run the Lab Project and Mike Gibson, former Science Inspector in Kingston-upon-Thames, to run the Resources Project. Some work was contracted to other experienced science educators, including Stan Hurst (a biologist and former science adviser in Staffordshire), Ray Vincent (a chemist and former Head of Science and Subject Officer at Edexcel) and Dick Orton (a physicist and former Senior Adviser at CLEAPSS). Several current CLEAPSS staff were also involved.

Questionnaires were sent to **every maintained secondary school in England**. The decision to avoid schools in the devolved administrations was taken by the RSC although the results would almost certainly be similar. Middle schools deemed secondary were included in the Lab Project but not in the Resources Project, hence the sample in the former project was a little larger than in the latter. No questionnaires were sent to post-16 colleges or independent schools.

Half the schools in each of the 148 LEAs in England were sent a questionnaire relating to laboratories, the other half received one relating to resources and budgets. Copies of the questionnaires are included as Appendices to sections 2 and 3 of this Report. There was a response rate of 42% on laboratories, and 26% on resources, phenomenally high levels of return, giving very high confidence in the results. The lower return rate on the resources questionnaire probably reflects its greater complexity and the difficulty of obtaining some of the information.

For the Lab Project, there was an attempt at triangulation by asking a small number of LEA science advisers to estimate the quality of labs in their LEA, with high levels of agreement between their figures and those of their schools. There were also discussions with a number of manufacturers about the cost of new build and refurbishment. Publications from the DfES Schools Design and Building Unit (previously, Architects and Buildings Branch) were consulted. Full details are given in section 2.

For the Resources Project, permission was obtained from the Royal Society to use their 1997 report *Science Teaching Resources: 11-16 year olds* as a starting point. The lists were reviewed in the light of curriculum and other changes and re-costed, with some help from Philip Harris Ltd. In addition, the costs of post-16 work were incorporated. This was done by analysing, for each of the main sciences, one leading examination specification, which has well-developed materials and resources clearly identified. Full details are given in section 3.

Of course, in a project of this size errors will inevitably arise. The questionnaires may have been incorrectly completed by school staff. Data from the questionnaires may have been mis-typed into the database. Equipment lists may have been wrongly costed. In our checking procedures we have identified some such errors but doubtless others remain. However, the scale of the exercise is such that it is extremely unlikely that any remaining errors would have anything more than a marginal effect on the overall conclusions.

1.1.3 Analysis of the results

The questionnaire returns were entered into a database by CLEAPSS staff, who then conducted an analysis in response to questions from the consultants. Results were analysed by type of school, under a number of criteria: community, foundation, etc; age range of pupils; selective or not; specialist school status.

LEAs were also classified as high-, medium- and low-spending based on the average pupil funding per head for 2001-2, as reported in the House of Commons *Hansard Written Answers* for 26th October 2001. The 148 education authorities in England were divided into three groups of 49 or 50, depending on where they were in the rank order. Note, however, that the low-spending LEAs tend to be shire counties and thus have more schools than the high-spending ones, which tend to be relatively small metropolitan authorities or London Boroughs.

The outcomes of these analyses are discussed in section 2 (for the Lab Project) and section 3 (for the Resources Project). A selection of the comments made by schools on the questionnaires have been included to give flesh to the bare figures. Detailed figures are given as Appendices to the two sections.

1.1.4 Acknowledgements

In all, almost 1200 questionnaires were returned by schools. We should like to take this opportunity to thank the staff of those schools for their willingness to find time during a busy day or, more probably, after a busy day, to complete the questionnaires. The amazingly high overall return rate of 34% is a tribute to the importance with which schools viewed this research.

We should also like to thank Philip Harris Ltd for some help in costing the resources in the 11-16 lists used in the Resources Project and to various suppliers and manufacturers who provided data on costs of new and refurbished laboratories. We should especially like to thank the Royal Society for its willingness to allow us to use, as a starting point, the resources lists it published in 1997.

Thanks are also due to the CLEAPSS administrative staff who dealt with all the mailings, set up the databases and handled the data entry and to the various consultants used mainly in drawing up and costing the equipment lists.

Finally, particular thanks are due to the two Project Officers, Andy Piggott and Mike Gibson, without whom this project would have been impossible.

1.2 Context of this Report

1.2.1 Other reports

By most international comparisons[1], the UK performs very well in school level science education. Statistics for GCSE and post-16 examinations show year-on-year improvements in the science subjects. Nevertheless, a succession of

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[1] *Third International Maths and Science Study* (TIMMS), 1999, First National Report, DfEE 2000.

Student achievement in England. Part of the OECD *Programme for International Students Assessment* (PISA 2000), Stationery Office, 2002.

reports have highlighted concerns about both the science curriculum and the facilities and resources for science teaching.

In 1997, the Royal Society published a report[2] *Science teaching resources: 11 – 16 year olds* which was sent to all secondary schools in the UK, including independent schools. This concluded that in an 11-16 school, £11.38 per pupil was the minimum sum needed to provide essential resources for practical science, not including books, reprographics, etc. Accompanying this report was a questionnaire about resource provision. There were 257 replies to the 4 700 questionnaires sent out and the results were analysed and published by the Association for Science Education[3] in 1998. A summary of the more relevant findings is shown in the table below. (Note that the table reports on GM schools, which are now largely voluntary-aided or foundation schools, as well as LEA and independent schools). It will be noted that whilst independent schools were close to the recommended figure, maintained schools were significantly below it, especially when reprographic and book costs are included.

	LEA schools	GM schools	Independent schools
Mean annual science capitation per pupil on roll	£9.4	£9.7	£11.4
Mean annual science reprographics costs	£1 875	£1 786	£2 390
Science class size at KS3	31.5	22.2	18.7
Science class size at KS4	23.1	17.7	15.8

The Ofsted Annual Report in 1999[4] estimated that in 20% of schools the science accommodation was of such poor quality that the teaching was directly affected.

In 2002, two major reports[5] both commented on provision for practical science. Sir Gareth Roberts reported a later Ofsted finding that 26% of laboratories were unsatisfactory and also an OECD finding that inadequate science equipment was hindering pupils' learning 'a lot' in 10% of UK schools and 'some' in a further 30%. Inadequate buildings were hindering pupils' learning 'a lot' in 5% of UK schools and 'some' in a further 38%. The House of Commons Select Committee made similar points about the poor state of

2 *Science teaching resources: 11 – 16 year olds,* London: The Royal Society, 1997.

3 *Science teaching resources: 11 – 16 year olds. The Survey Findings*, P Ramsden, *Education in Science,* 180 (November 1998), pp 19 – 21.

4 Ofsted Annual Report for 1997/8, 1999.

5 *Set for success. The supply of people with science, technology, engineering and mathematics skills.* The report of Sir Gareth Roberts' Review for HM Treasury, London, April 2002.

Science Education from 14 to 19. Third Report of Session 2002-02 of the Science and Technology Committee, House of Commons, London, July 2002.

laboratory facilities and the inadequacy of funding for equipment and consumables.

Early in 2004, the Save British Science Society reported[6] on a small-scale survey of secondary school science teachers, with very similar results to those which are reported here, although this report is based on far larger numbers.

In Scotland, a small survey of spending on physics departments has recently been published[7]. In that physics tends to have high capital costs but relatively low consumable costs the results are not directly comparable with the current survey, which covers all the sciences.

	State schools (n = 58)	*Independ. schools (n = 8)*
Mean physics department budget 2001	£4899	£5339
Mean physics department budget 2003	£4466	£6047
Mean physics department budget per pupil-hour 2001	15.5 p	22.6 p
Mean physics department budget per pupil-hour 2003	13.6 p	26.6 p

The survey also estimated the proportion of the budget going on ICT, photocopying, textbooks, etc.

Spending category	*State schools (n = 58)*	*Independ. Schools (n = 8)*
Equipment - physics	36%	64%
Equipment - ICT	12%	10%
Photocopying, textbooks & stationery	54%	26%

1.2.2 Government and other initiatives

In response to the 1999 Ofsted report, the Government launched a two-year programme of laboratory refurbishment and rebuilding under the Capital Modernisation Fund. £60 million was available from 2000 to 2002 for the improvement of obsolete school laboratories. It was reported that this was expected to deal with some 400 of the then estimated 750 schools with unsatisfactory science accommodation. However, an independent evaluation of this programme by PricewaterhouseCoopers [8] published by the DfES in November 2003, supports many of the issues raised in this report. It points to the inadequacy of the funds provided to address historic under-investment, but also to the successes when funding is sufficient to create a good standard of laboratory provision. A more detailed analysis and comparison with this survey and report is given in section 2.5.

In February 2004, the government announced a further initiative, *Building Schools for the Future*. The aim is to rebuild or refurbish every secondary school in England. The first wave in 2005 – 6 will invest £2 200 000 000 in 180 schools,

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6 *SBS Survey of Secondary School Science Teachers*, SBS (The Save British Science Society), London, January 2004.

7 *SSERC Bulletin 210*, Edinburgh: SSERC, 204.

8 *Evaluation of Science Laboratory Funding. Final Report*. DfES, November 2003.

ie, a little over £12 000 000 per school. Further funds will be released in 2006 – 7 and 2007 – 8, although, if on a similar scale, this will still only give a total of 540 schools, around 15% of the total number and of course only a small part of this will go towards science departments.

It has been recognised for some time that there was dissatisfaction with the design of even some new laboratories. Often this is because of insufficient consultation between designers and those in schools who will use the accommodation. In 2003 the Royal Society and the National Endowment for Science, Technology and the Arts (NESTA) jointly funded a national project, *Laboratory Design for Teaching and Learning*. This was managed by the Association for Science Education (ASE) and had the active support of the CLEAPSS School Science Service and the DfES. The aim was to improve the involvement of end-users, ie, teachers and technicians, in the design process. One outcome was the production of software to allow schools to design laboratory layouts (see www.ase.org.uk/ldtl/).

1.3 Summary of the Laboratory Project Report

1.3.1 Questionnaire findings

The major part of the research for this report was carried out by a questionnaire, sent to science teachers and technicians. Questionnaires were posted to half of all English maintained secondary schools, with a very high return rate of 42%. The data were then tested against evaluations provided independently by science advisers, inspectors and consultants.

In this summary, only the overall figures are reported, as the responses returned were highly consistent across a wide variety of subgroups.

There are around 26 340 science laboratories in maintained secondary schools in England. Of these, only 35% are graded good or excellent. Of the remainder, 25% are considered either unsafe or unsatisfactory for the teaching of science. That is, about 6 560 laboratories ought not be used, and a further 10 695 are uninspiring to both pupils and teachers. At the same time, teachers report that they need one additional laboratory per school, on average, to be able to teach all science lessons in a laboratory; that is, an under-provision of 3 518 laboratories. It will be noted that the first three years of the Government's Building Schools for the Future programme (see section 1.2.2) will only deal with about 15% of the schools, ie, not much more than half of those which would have laboratories considered unsafe or unsatisfactory.

Put another way, these statistics show that when pupils are in a science laboratory, their experience is unsafe, unsatisfactory or uninspiring for 65% of the time. This does not include the 13% of the time that they are not in a laboratory at all.

Fume cupboards are essential for the demonstration of some chemistry experiments and for the learning of skills by pupils at higher levels. Two extra fume cupboards are needed in 63% of all schools for teaching at Key Stages 3 and 4, and two more in 81% of schools teaching at A/S and A2 levels.

In the preparation areas that support science teaching, 36% are described as good or excellent, with 21% described as poor. Similar percentages describe the storage and preparation space available to science technicians. Fume cupboards are lacking in 47% of science departments' preparation areas and there are no dishwashers in 34%. Where departments are on more than one floor, 65% of departments lack a lift of any sort to enable equipment to be carried between floors. However, the design of departments has generally meant that prep rooms are easily accessible to the laboratories that they serve, with 65% of responses showing accessibility as either good or excellent.

The responses are summarised schematically in Figures 1 and 2 (page 9).

1.3.2 Cost of improving laboratory standards

The total cost of improving laboratory standards obviously depends not only on assumptions about the number of laboratories needed and their existing quality but also about the cost of new build and refurbishment. These assumptions are discussed in the main report, see section 2.2 and *Appendices* 2.14 and 2.15.

If all the issues were addressed at once, and upgrading was to a good (as opposed to an excellent) standard, a conservative estimate of the total finance needed would be around £1 380 000 000. The components of this total are as follows.

Upgrade all unsafe / unsatisfactory laboratories to a good standard	£361 000 000
Upgrade all basic laboratories to a good standard	£321 000 000
Build sufficient new laboratories	£510 000 000
Provide sufficient fume cupboards	£41 000 000
Upgrade all preparation areas to a good standard	£89 000 000
Extend preparation areas	£24 000 000
Provide sufficient dishwashers	£6 000 000
Minimum cost of lift provision	£28 000 000
TOTAL	**£1 380 000 000**

It is interesting that the new government initiative (see section 1.2.2) will spend a total of £2 200 000 000 on school building and refurbishment in the first year (2005-6). If we assume that building a science department costs about 14% of the total costs of a school[9] then this programme will contribute just over £300 000 000 to science. At that rate of spending, over a period of 4 – 5 years it would be possible to address the issues raised in this report if the

[9] Personal communication from DfES Schools Design and Building Unit.

finance is spent as intended and does indeed continue at that level for that length of time.

Of course, there is scope to debate the precise costs. When £60 000 000[10] was released by the government in the two-year period 2000 - 2002 specifically to improve laboratory provision it was estimated that this would cover about 400 projects, ie, at a cost of about £150 000 per school, but it was not clear what that was intended to achieve. In this report, we have assumed that the cost of a new laboratory is £145 000 and the cost of refurbishment much less than this (£55 000 to achieve a good standard and in some cases £30 000 if starting from a better base). However, £150 000 per school would not achieve that needed for science in these schools, let alone all the other schools in need.

Probably the biggest uncertainty is in the cost of upgrading basic standard laboratories to good standard, as the amount of work needed will vary enormously. At the conservative end, as little as £11 000 per laboratory may be needed. Using this figure only about £120 000 000 would be required, bringing the total down to £1 170 000 000.

Also, it is possible that the survey was biased in that schools with good or excellent facilities failed to respond in proportion to their numbers. However, even upgrading the 1386 unsafe/unsatisfactory laboratories in the sample which did respond would cost about £76 000 000. Similarly, upgrading the 2262 basic laboratories in the sample would cost at least a further £68 000 000. Providing the missing laboratories in the sample schools would cost about £108 000 000. Adding in the costs of upgrading the unsafe/unsatisfactory prep rooms and storage areas in the sample schools, providing them with sufficient fume cupboards, etc would cost around £39 000 000. This gives a total for the 744 schools of around £291 000 000. Assuming a similar proportion in the schools not sent this questionnaire, this would scale up to a total of about £564 000 000. This must certainly be an under-estimate.

10 *School Laboratories for the 21st Century*, part of HM Treasury's *Capital Modernisation Fund*.

Figure 1 *The Average Department*

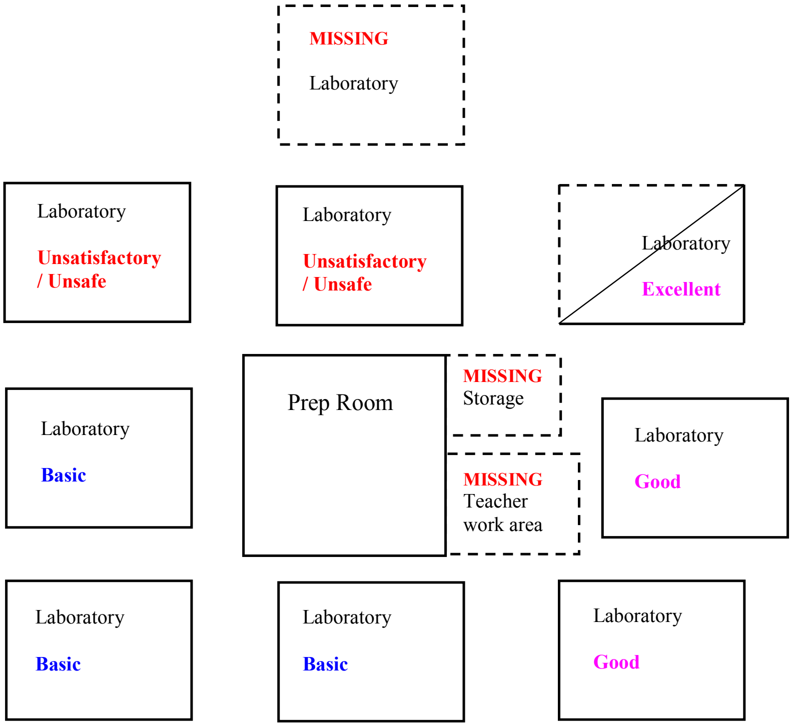
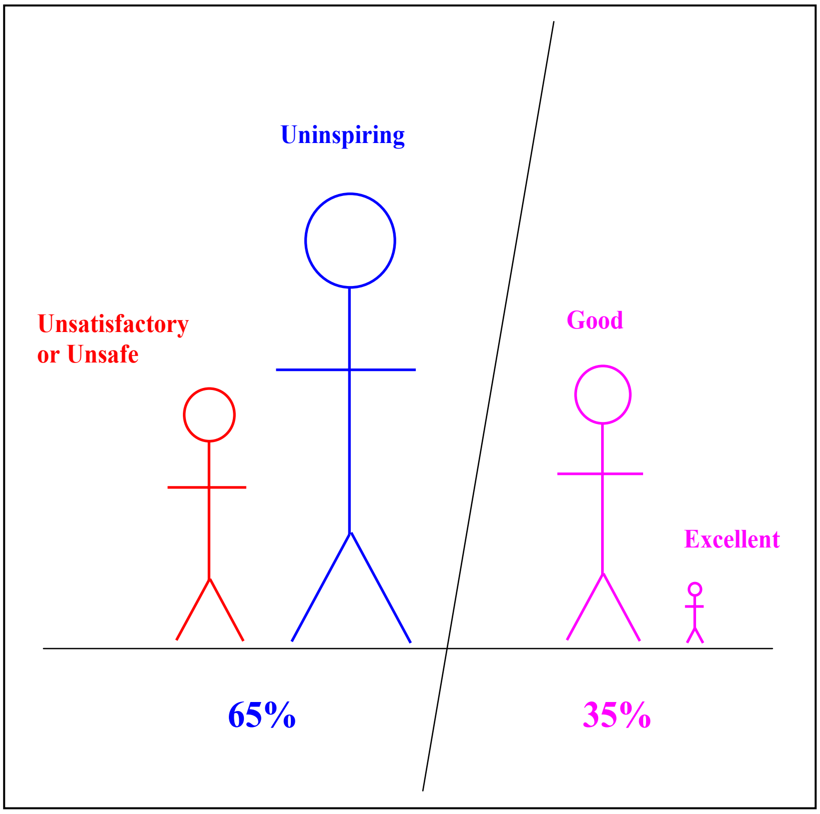


Figure 2 *Pupils' experience in science laboratories*



1.4 Summary of the Resources Project Report

1.4.1 Questionnaire findings

This report summarises the findings of two parallel investigations. The first is a study of income which science departments actually receive, the uses to which they put the funding and the main areas of need that they identify. This was explored through a questionnaire which was circulated to half of all English maintained secondary schools, ensuring that there was an appropriate balance between the different types of secondary school and their locations. There was a very high return rate of 26% indicating the importance which schools placed on this issue.

The second theme was the cost of providing the resources to enable schools to teach science effectively (see section 1.4.2).

The questionnaire was analysed (for details, see *Appendices* 3.3 and 3.4) and showed that the average sum made available to science departments in all maintained schools in the current financial year (2003 – 2004) is **£9.89 per pupil**. This figure has remained almost stable over the past two years despite rising prices. The average for each pupil in 11 to 16 schools is **£8.78 per year** and **£10.66 per pupil per year** in 11 to 18 schools. Grammar schools and voluntary-controlled schools receive more per pupil on average than other types of school. Schools in high-spending LEAs receive rather more than those in other LEAs. However, the relationship is not a simple one since science departments in low-spending LEAs receive more money annually per pupil to teach science than those in medium-spending LEAs.

These figures are clearly well below the cost per pupil as estimated in this survey (see *Appendix 3.14*) especially when taking into consideration that in most schools this sum has to cover the cost of text books and photocopying and, in some cases, repairs, subscriptions and other items.

In addition to a low average sum available per pupil there is also a surprisingly wide range in this sum. In the current year, the range is from £0.64 per pupil to £71.43 per pupil. It is difficult to see the justification for such extremes. At the lower end, the impoverishment of the curriculum is likely to affect pupils' motivation and their interest in continuing with the study of science..

Over 90% of schools responding judged that their funding was inadequate to sustain an effective level of science education.

The system of funding most commonly employed by schools is a combination of a formula and a bid. Where a formula is used this commonly includes factors for the number of pupils, their ages, the amount of science taught and a subject-specific weighting. However, bids are rarely fully met because schools are short of funds overall and it is less common to find that there is spare funding available later in the year to meet subsequent bids.

The major areas of need identified were: replacement of large items of equipment, many being very old, purchase of new large items needed to keep up to date, text books, ICT hardware and software and basic science equipment. Shortfalls were so severe that, in some cases, comments suggested that schools were not able to meet fully the requirements of the National Curriculum, especially in ICT. Practical work was being cut down. Ageing microscopes and low voltage power packs resulted in demonstrations replacing pupil practical work and pupils were getting insufficient experience of Sc1 investigations. Particular concern was expressed about the adequacy of provision of, and access to, ICT equipment by a significant majority of schools. When asked what science departments identified as the top priority if any funding was available, many added laboratory replacement or refurbishment as an additional priority to those mentioned above, thus confirming the findings of the laboratory survey. No allowance is normally made for depreciation in schools.

1.4.2 Cost of essential science resources

The costing exercise was based on a report on the science teaching resources list for schools produced by the Royal Society in 1997[11]. This has been revised and updated and extended to encompass the complete secondary age range from 11-18. Note that resources include not only equipment but also chemicals and biological and geological materials and specimens. Note also that, as with the Royal Society report, depreciation costs have been built in, although schools are rarely able to do that. In assessing basic resources required to provide an effective science education for pupils aged 11 to 18, we have taken account of the increased emphasis on continuity with Key Stage 2, a greater emphasis on practical and investigatory science, a substantial increase in the expected use of ICT in science, the wider range of science-based courses including those with a vocational bias and the introduction of AS and A2 examinations. The costings have been based on 2004 prices and make allowances for potential discounts which schools can obtain. The revision provides an 'essential' list of resources and a 'desirable' list. The latter includes items which more fortunate schools use to teach science more effectively. Often these are items which are essential for post-16 work but can enhance the curriculum in KS3 and 4.

In addition, the list was extended to cover post-16 work. Three leading and highly respected specifications were selected, being chosen because they had a well-developed package of support materials from which it was possible to identify resource requirements. All three were the result of curriculum development projects: Salters' Nuffield Advanced Biology, Nuffield A-level Chemistry and Advancing Physics (Institute of Physics). Choosing other specifications would alter some of the details of the lists and the costs but the

11 *Science teaching resources: 11 – 16 year olds*, London: The Royal Society, 1997.

view of the professionals involved was that the total costs would be little different. These post-16 lists cannot be regarded as quite as reliable as the 11-16 list but nevertheless give a useful indicator.

The results show that, for a science teaching group of 24, the cost of essential resources required to provide an effective science education for pupils has risen from £11.38 per pupil aged 11 to 16 per year in 1997 to **£20.58 per pupil per year** (see *Appendix 3.14*). If desirable resources are also included, the cost rises to £29.14 per pupil per year. **These figures do not include costs of text books, photocopying, repairs, subscriptions, (or personnel)**. Much of the increased cost can be attributed to the emphasis on ICT in the current curriculum, although some chemicals and equipment have increased in price by more than inflation.

Unlike the original Royal Society report, we also investigated the effect of teaching larger classes. Some costs are fixed, irrespective of the size of the class. This is mostly the items used by teachers in demonstrations, eg a van de Graaff generator. Other costs depend on the number of pupils in the class, eg more microscopes will be needed at the same time in a larger class. Where the class size is 30 the costs rise to **£22.22 per pupil per year for essential** resources and £30.75 per pupil per year for if desirable resources are included. Of course, a school will make savings in a class size of 30 by needing fewer laboratories and fewer teachers but the additional cost of resourcing larger classes is often forgotten.

For a teaching group size of 24, these figures therefore show a minimum shortfall of about **£11.80 (£20.58 - £8.78) per pupil per year** for 11 to 16 year olds to meet even the essential level of resources *excluding* textbooks and the other items identified above. The shortfall would rise to **£20.36 (£29.14 - £8.78) per pupil per year** if desirable resources are also included. For a teaching group size of 30 the corresponding shortfalls would be £13.44 (essential only) and £21.97 (essential + desirable).

According to DfES[12] statistics there were 2 916 590 pupils within English secondary schools in the age range of compulsory education in 2002. This means that **each year** for classes of 24 there is a national shortfall **of nearly £34 million** even to cover essential resources. The annual shortfall rises to nearly **£59 million** if desirable items are included. For pupils taught in classes of 30, the shortfalls are nearly **£39 million and £64 million respectively.** Assuming that only about half the classes are taught in groups of 30 (almost certainly an underestimate) in round figures it is reasonable to say that science departments need **at least a further £37 million per year** to provide a reasonable level of resources for teaching science to 11 to 16 year olds, ie **more than £10 000 more per science department per year.**

12 *Statistics of Education 2003*, London: DfES, 2003.

It is less easy to provide an accurate figure for the cost of providing resources for advanced science courses. Sixth-form numbers vary enormously, as does the relative uptake of the different science subjects. For this exercise, we have assumed one group of 20 pupils in each of AS biology, chemistry and physics and a further group of 16 in A2 in each subject, in all 108 pupil-subjects.

It is possible to obtain an estimate of what schools actually allocate to advanced science courses using the model school. The average 11 to 16 school using the model spends £8.78 on each of its pupils per year on science, while the 11 to 18 school spends £10.66. Thus at 11 to 16, typically £6 585 (£8.78 x 750) will be allocated annually. From the 11-18 schools responding to our survey, we estimate for every 1008 pupils aged 11-16 there are 209 post-16 pupils. So we can estimate that a school with 750 pupils aged 11 to 16 will have about 156 6th formers (of course, not all taking science subjects but some taking two or even three), ie, in all 906 pupils. At £10.66 per pupil, this gives the average 11-18 school £9 657.96. (£10.66 x 906). Comparing this with the £6 585 for an 11-16 school, it would follow that the additional money spent annually on post-16 science would be £3 072.96. This would be available to spend amongst the 108 pupils assumed to be studying advanced sciences, ie **£28.45** per pupil per year per science subject studied.

Because pupils choose different numbers of science subjects post-16 it is not possible to give a typical cost for providing an effective science education for this age range. However, it is possible to work out an approximate annual cost for each of the three main sciences post-16 averaged out over a two year course based on the advanced level subject lists *still excluding items such as textbooks, photocopying, resources servicing and subscriptions*.

	Cost per pupil per year averaged over two years ESSENTIAL ITEMS ONLY	Cost per pupil per year averaged over two years ESSENTIAL + DESIRABLE ITEMS
Biology	£34.82	£43.83
Chemistry	£93.78	£93.78
Physics	£296.82	£436.91

It is clear that the actual cost of even just essential items is far greater than the average **£28.45** per pupil per science subject per year schools actually allocate at present and even where a full 10% discount is estimated for all items. The actual shortfall ranges from about £6 per pupil per year for biology to almost £270 per pupil per year for physics. It is possible that this discrepancy in physics is one cause of the relative unpopularity of physics as a degree subject and of the well-known shortage of physics teachers.

The gap is even greater when desirable items are included especially when it is considered that the sum allocated by schools usually has to encompass all costs associated with science and not just those identified in the resources lists. As for pupils aged 11 to 16, this leaves a massive shortfall in current funding in most schools even when only essential resources are taken into consideration.

The DfES statistics quoted above also showed that there were 329 910 pupils within English secondary schools in the 16 to 18 age range. Even if only about half of these were studying science this would amount to about 160 000 pupils. The size of the shortfall for post-16 work depends on which science subjects they are studying. At the very least it is **£1 million and at the most £54 million,** even to cover essential resources. The annual shortfall rises even further if desirable items are included.

Further research is needed to widen the scope of this review to all educational institutions which offer advanced post-16 courses in science and to establish in greater depth the degree of the financial shortfall.

Whilst some of the assumptions made in this report may be questioned and there might be arguments about the details, both pre- and post-16, it seems inescapable that a very substantial amount is needed to upgrade the quality of school science resources. Moreover, this would not be a one-off cash injection but a continuing commitment to maintain a minimum standard of provision including allowing for the depreciation of capital items and their replcement. Unless science is taught in an up-to-date manner, using modern equipment, there is little likelihood that young people will be motivated to continue their study of science. For those who do, there is even less likelihood that they will want to return to schools, as teachers.

2 Laboratory Project Report

2.1 Methodology

A set of criteria for judging the quality of science laboratories in schools was compiled; see *Appendix 2.1*. These criteria were written using the extensive experienced gained at CLEAPSS, from research carried out in 2003 for the *Laboratory Design for Teaching and Learning* project[13], and from the professional experience of the authors and other science advisers and consultants.

Questions for the questionnaire itself were written from the same background of experience, addressing issues that are known to be of concern to those who work in science laboratories and preparation rooms. The opportunity to add comments to the answers to questions was made available but not emphasised. The whole questionnaire was trialled with the science departments of ten schools. There was input from several science advisers and also two laboratory equipment manufacturing /design firms. As a result of the comments received, some minor changes were made to some questions and to the criteria themselves; see *Appendix 2.2* for a copy of the final questionnaire.

The questionnaire was sent to half of all maintained secondary schools in England (including middle deemed secondary schools), addressed to the Head of Science / Senior Technician, ie, every other school listed on the CLEAPSS database of school addresses. Of the 1759 questionnaires thus sent out, 744 were returned; a return rate of 42%. This is a huge return rate and must reflect the importance which science teachers and technicians place on this issue. Teachers returned 52% and technicians 44%. Although the invitation to add comments was not emphasised, many respondents did in fact take the opportunity to do so. In total, nearly 28 000 words of comment were added, by far the greater majority being critical of laboratory or prep room provision. These comments also give insight to further issues not actually asked about in the questionnaire.

Some respondents failed to answer all questions, but for every question there were at least 700 responses from the 744 forms overall; 44 / 744 gives an error rate of only 6%. For a few individual questions, the question itself had been occasionally misunderstood and some answers are obviously incorrect. For example, the question on 'fume cupboards needed' resulted in some respondents giving the total number needed, rather than the <u>extra</u> number needed. Analysing the distribution curve of responses, it is possible to see where the answers change. Discounting those with obviously too high a number, gives 14 'wrong' replies out of 447, or 3%; this gives a bigger

[13] *Laboratory Design for Teaching and Learning* was a national project, managed by the Association for Science Education, funded jointly by the Royal Society and the National Endowment for Science, Technology and the Arts (www.ase.org.uk/ldtl/).

percentage error in the number of fume cupboards needed; 116 / 1037, or 11%.

Reliability of the questionnaire data is assured by the sheer number of respondents. Of 148 LEAs involved, there were only nine in which no schools responded, accounting for only 51 schools in the mail-out sample. Analysis of replies shows a tremendous consistency across a wide range of sub-groups. See A*ppendices 2.4* to *2.12*.

These subgroups were as follows.

- Schools in High, Medium and Low-spending local authorities.
- Comprehensive, Grammar, Secondary modern, Specialist science, Specialist (non science).
- Community, Foundation, Voluntary controlled, Voluntary aided.
- Age ranges: 11-16, 11-18, 14 -18, Middle deemed secondary.

The only slight variation is in the number of respondents from high-spending local authorities[14] (see section 1.1.3). The difference between the number of questionnaires sent to schools in such authorities and the number returned is 3% points less; 21% of the questionnaires went to schools in high-spending authorities and 18% of questionnaires were returned from such schools. However, where there is any difference at all between replies from schools in higher- and lower-spending authorities, it is for schools in higher-spending authorities to give replies towards the unsatisfactory end of the spectrum.

The agreement between replies to questions is high and to the unsatisfactory end, which might lead to a possible charge of respondents 'ticking boxes' in order to vent their frustration. This is refuted by the response to Question 20. This deals with the accessibility of prep rooms and storage areas to the laboratories which they serve. Here the response is very positive, showing that respondents are reading and responding to the questions rather than any overall 'unsatisfactory' pattern.

Validity of the data is important. The data all come from science staff working in individual schools and therefore represents their own perceptions of the working environment, albeit influenced by the criteria for laboratory quality sent with the questionnaire. Independent views were therefore sought from science advisers and inspectors working in LEAs. These people spend their working life visiting, checking and evaluating science teaching and provision in schools. Six advisers and consultants from across a range of LEAs (rural, urban, suburban: high-, medium- and low- spending) each gave their professional opinion on the state of the laboratories in their authorities (*Appendix 2.13*); some from surveys already completed, others from a personal overview. The results tallied well with the data from the questionnaires, with the percentage of basic and unsafe/unsatisfactory laboratories together being

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14 *Hansard Written Answers* for 26th October 2001, House of Commons.

similar. However, science advisers tended to put the percentage of unsatisfactory / unsafe laboratories at higher levels than teachers and technicians in schools. For one LEA there is both the science adviser's opinion and the questionnaire results from 19 schools; the agreement is very good indeed for basic and unsafe/unsatisfactory provision, although the adviser has put more laboratories in the unsafe/unsatisfactory category. An independent science consultant was able to identify and review the responses from 8 individual science departments, having conducted health and safety audits in each of them over the past few years. In six cases, the school's judgement was confirmed; in the other two cases, the percentage of basic and unsafe/unsatisfactory is confirmed but the school has put more into the unsafe/unsatisfactory category.

The statistical department of OFSTED was approached, but was unable to help with judgements made specifically on science accommodation during inspections. This is because only the overall accommodation grade is stored centrally. Science team inspectors do judge the standard of laboratories; indeed all three of the authors of the overall report have been involved in this as OFSTED inspectors. Unfortunately, these judgements are only recorded at contractor level, not at OFSTED level. However, the Roberts' review[15] quotes OFSTED figures of 26% of school laboratories being unsatisfactory and 40% satisfactory, remarkably close to the figures found in this survey. The House of Commons Select Committee Report[16] repeats these figures. At the very least, this means that the unsatisfactory condition of many school science laboratories is not a new phenomenon.

The *SBS Survey of Secondary School Science Teachers*[17] looked at laboratory space and class size as well as the effects of the condition of laboratories on teacher recruitment and retention. This survey posted out a questionnaire to maintained schools in 22 English LEAs; a total of approximately 464 schools. It achieved a return rate of just over 14% and had nearly 60% of its target schools in high-spending LEAs (high-spending as judged by the method used in the current survey). It found that science practicals were prevented by (too large a) class size in 46% of cases and by lack of laboratory space in 29% of cases. Respondents thought that the condition of their laboratories adversely affected teacher recruitment in 55% of cases and teacher retention in 40%.

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15 *Set for success. The supply of people with science, technology, engineering and mathematics skills.* The report of Sir Gareth Roberts' Review for HM Treasury, London, April 2002.

16 Science Education from 14 to 19. *Third Report of Session 2002-02 of the Science and Technology Committee*, House of Commons, London, July 2002.

17 *SBS Survey of Secondary School Science Teachers*, SBS (The Save British Science Society), London, January 2004.

2.2 Costs of Improvement

(See *Appendix 2.14* for more detail.)

The costs of building new laboratories or refurbishing existing ones have already been addressed by the Schools Building and Design Unit of the DfES (as it now is). These costs were reported in its publication *Science Accommodation in Secondary Schools, Building Bulletin 80*[18], revised 1999. For this report, these costs have been updated to 2003 by applying a correction from the Retail Price Index of 9.5%.

Costs were also checked with information supplied by firms who design, manufacture and install equipment in science laboratories and prep rooms, some of whom also manage whole refurbishment projects. Some LEA advisers and heads of science also contributed cost information.

From these sources, indicative costs have been chosen to calculate the figures in this report. Where estimates have been made, they have generally been chosen to be on the conservative side.

2.2.1 Building a new laboratory

The 1999 costs for constructing and fitting out a new science building are reported in *Science Accommodation in Secondary Schools* as being in the range £1000 to £1400 per m^2 of gross floor area. The rise in Retail Price Index from 1999 to 2003 is 9.5%, increasing the DfEE figures to £1 100 to £1 500 per m^2.

Allowing 10 m^2 for corridor space and 15 m^2 for a share of prep room space, a laboratory of 90 m^2 would need 115 m^2 overall. This would mean a new build cost of £126 500 to £172 500 or £149 500 on average.

Therefore, to build a new laboratory a conservative estimate is … **£145 000.**

Note that this is a little *less* than the figure used in 2000 - 2002 when over a two-year period the government specifically ear-marked £60 000 000 for laboratory improvement[19]. At the time it was estimated this would cover some 400 projects (ie, £150 000 each). In practice, the money seems to have been spread more thinly[20] and may account for some of the comments received in the current survey that even new or newly-refurbished laboratories were sometimes rated no better than a basic standard.

18 *Science Accommodation in Secondary Schools, Building Bulletin 80,* DfEE, London: The Stationery Office, 1999.

19 *School Laboratories for the 21st Century*, part of HM Treasury's *Capital Modernisation Fund*.

20 *Evaluation of Science Laboratory Funding*, DfES, Final Report, Nov 2003, being an independent evaluation by PricewaterhouseCoopers of the £60 000 000 allocated to LEAs in 2000-2002 to improve school laboratories.

2.2.2 Refurbishing an existing laboratory

The 1999 costs for refurbishing laboratories are reported in the DfEE publication via three case studies. Case Studies 1 (involving five laboratories and two prep rooms) and 3 (involving three laboratories) were considered reasonably typical. Case Study 2 was considered less relevant for the purposes of this report because it involved knocking together two small rooms and then laying out one long, narrow laboratory. The average cost of three options for Case Study 1 is £366.2 per m^2, while the cost for Case Study 3 is £561.5 per m^2. Both case studies were adaptations of existing buildings and the costs of different furniture systems were explored. However, the main reasons for Case Study 3 being more expensive were the use of higher-quality worktops, more builder's work in adapting the existing structure and services and the need for some non-standard components.

Applying the change in RPI up to 2003 increases the figures for Case Studies 1 and 3 to £401.0 per m^2 and £614.8 per m^2 respectively. This would mean refurbishment costs for a 90 m^2 laboratory of £36 100 to £55 300.

Two design and manufacture firms, who also project-manage refurbishments, gave the following estimates to refurbish one laboratory to what they call a 'basic standard'.

Work	***Firm A***	***Firm B***
Supply and fit furniture	£12 000 to £15 000	£15 000 to £17 000
Supply and fit fume cupboard + ducting	£3 800	£4 000 to £6 000
Install / alter services	£3 000 to £6 000	£3 000
Strip out		£3 000 to £5 000
Gas controls	£1 200 to £2 000	
Resurface floor	£4 000	£4 500 to £5 500
New ceiling	£2 000 to £3 000	
New ceiling + lighting		£5 000 to £6 000
Decoration	£1 500	£1 000
Total	£25 500 to £35 300	£34 000 to £43 500

This 'basic standard' is for cheap ranges of furniture and bench surfaces and does not include window blinds, nor any provision for ICT. Such refurbishment would therefore not provide a 'good' laboratory by the standards of this report. As a further guide, Firm A quoted from a recent installation a cost for a 'high quality' laboratory of £65 000. This included better-quality furniture, with higher specification steel tubing for the bench frameworks and *Corian* work surfaces. The construction work also included a presentation area, with pre-laid wiring for ICT. The project was managed by Firm A itself, while the equivalent LEA-managed price apparently would have been £110 000.

None of these estimates includes any allowances for structural work, roof repairs or replacement of windows; these are all items that are often badly needed in the upgrading a laboratory. Indeed, the 'high-quality' laboratory installed by Firm A, still suffers from a leaking roof that was not made part of the project at the time.

Two other firms confirmed the 'supply and fit furniture' costs. An LEA science adviser quoted a 'typical cost per laboratory' of £45 000. One head of science from the survey quoted 'Two recent laboratory refurbishments' each at £50 000.

To refurbish a laboratory: Unsafe/Unsatisfactory to a Good/Excellent standard

To refurbish a laboratory from scratch, it would not seem unreasonable, taking the above figures into account, to use a figure of £45 000. Allowing for a very small amount of minor building works, along with blinds and presentational ICT for example, might add, conservatively, a further £10 000.

Therefore, to refurbish an existing laboratory which is Unsafe/Unsatisfactory to a Good/Excellent standard, a conservative estimate is … **£55 000.**

To refurbish a laboratory: Basic to a Good/Excellent standard

The criteria for 'Basic' in this report cover a wide range. At the top end, the furniture will not need replacing and, from the costs above, might include only the following.

Decoration	£1 000
Resurfacing floor	£4 000
Ceiling + Lights	£6 000
Total	*£11 000*

At the bottom end, costs may approach those for a full refurbishment above, i.e. £55 000. An average of 'top' and 'bottom' refurbishment costs is £33 000.

Therefore, to refurbish an existing laboratory which is only Basic to a Good/Excellent standard, a conservative estimate is … **£30 000.**

2.2.3 Conversion of other rooms or building to science laboratories

Conversion may involve a considerable amount of extra building work, which cannot be estimated as it varies so much from case to case. However, all the costs of refurbishment from scratch would be incurred. In addition, there will usually not be gas, water supplies or drainage. Therefore 'Conversion' is assumed to cost at least as much as 'Refurbishment from Unsafe/ Unsatisfactory to Good/Excellent standard'.

2.2.4 Extending prep rooms

In the context of this report, the prep room is taken to include all spaces that are used for storage, preparation and work outside a teaching laboratory.

The amount of storage space is 'poor' in 18% of prep rooms, while the amount of preparation space is poor in 24%. This takes no account of the much larger percentages in which space is described as 'basic'. On top of this, many comments point to inadequate space for teachers to prepare their work.

Finding more prep room space would probably mean reallocations from other rooms in the school. However, the end result would be an overall requirement for more building. The average size for a prep room is reported in the DfEE publication as 110 m^2 (Example A, page 28). An increase in the floor area of around a fifth of the total (22 m^2) is thought to be reasonable. This is about the size of a large reception room in a private house; for a department with 8 teachers and 3 technicians, this would give an extra 2 m^2 per person for all purposes.

The cost of a new build (see section 2.2.1) is £1100 to 1500 per m^2, giving costs for 22 m^2 of £24 200 to £33 000.

Therefore, to extend a prep room by 20% of its floor area, a conservative estimate is … **£28 000.**

2.2.5 Refurbishing an existing prep room

The average size for a prep room is reported in the DfES publication as 110 m^2 (Example A, page 28).

To refurbish a prep room from Unsafe/Unsatisfactory to a Good/Excellent standard

Using estimates as in section 2.2.2, the cost of refurbishing a 90 m^2 laboratory from Unsafe/Unsatisfactory to Good/Excellent is £55 000. From this, deducting £5 000 for presentational ICT (not needed in the prep room) gives a cost of around £50 000 to refurbish a 90 m^2 prep room.

A pro-rata increase for a prep room of 110 m^2 is £61 100.

Therefore, to refurbish an existing prep room which is Unsafe/Unsatisfactory to a Good/Excellent standard a conservative estimate is … **£60 000.**

To refurbish a prep room from Basic to a Good/Excellent standard

Again, as in section 2.2.2, the cost for refurbishing a 90 m^2 laboratory from Basic to Good/Excellent is estimated at £30 000. From this, deducting £5000 for presentational ICT gives £25 000 to refurbish a 90 m^2 prep room.

A pro-rata increase for a prep room of 110 m^2 is £30 500.

Therefore, to refurbish an existing prep room which is only Basic to a Good/Excellent standard a conservative estimate is … **£30 000.**

2.2.6 Fume cupboards

The cost of supplying and installing a fume cupboard with its associated ducting is taken from the estimates given by Firms A and B in section 2.2.2.

Therefore, to install a fume cupboard a conservative estimate is … **£4400.**

2.2.7 Dishwashers

The lowest price of a laboratory dishwasher (from the Fisher Scientific catalogue) is around £4500.

Therefore, assuming services are already in place (hot and cold water, mains electricity, drainage), to install a dishwasher a conservative estimate is … **£4500.**

2.2.8 Lifts between floors

Discussion with a representative from OTIS (specialists in lift installation), suggests that the cheapest option for creating a lift between two floors for the safe movement of laboratory equipment is to install a standard eight-person lift, rather than a custom-built hoist. This also would allow wheelchair users to gain access to higher floors.

An eight-person lift supplied and fitted between just two floors, would cost approximately £20 000, not including any extra building works that might become necessary. Obviously, some science departments may be based on more than two floors, which would lead to even higher costs. If a passenger lift is installed a long distance away from the science areas, then a hoist will need to be considered in addition.

Therefore, to install a lift, a conservative estimate is … **£20 000.**

2.3 Detailed results of the survey

2.3.1 The quality of science laboratories in schools

Results of the data from questionnaires are given here, along with comments given on the questionnaires by science teachers and technicians.

	Laboratories	Unsafe / Unsatis.		Basic		Good		Excellent	
	Nº	Nº	%	Nº	%	Nº	%	Nº	%
Sample, from *Appendix 2.4*	**5569**	1386	**24.9**	2262	**40.6**	1641	**29.5**	280	**5.0**
For all English maintained schools	**26 340**	6560	**24.9**	10 695	**40.6**	7770	**29.5**	1315	**5.0**

The overall statistics of teachers' and technicians' views of their working accommodation are as in the table above.

It is clear that there is a great deal of dissatisfaction with the current state of laboratories and prep rooms, which was partly the rationale behind the *Laboratory Design for Teaching and Learning* project (see section 1.2.2.)

Excellent and good standard laboratories

Approximately 35% of all laboratories are regarded as good or excellent. That is (see Criteria, *Appendix 2.1*), they have good facilities for teaching and learning and are kept well decorated and maintained. Those in the excellent category have good ICT facilities as standard. The point has been made from different quarters that those planning and installing new or refurbished laboratories can usually only attain the 'good' standard, as described in the criteria. It is only schools, in most instances, who can take the extra step to make a laboratory 'excellent', as items such as data projectors and computers are usually excluded from refurbishment budgets.

A few teachers and technicians commented on good provision.

- *Recently moved into 3 purpose-built new laboratories. Consultation has been excellent. Large provision for IT …*
- *Our labs have been significantly upgraded since we became a science college – all labs have a data projector and interactive whiteboard. 6 labs are newly built as part of a separate PFI scheme and are good labs.*
- *Our newly-refurbished "good" laboratories are having a significant, positive effect on pupils' and teachers' motivation. They also raise the perceived status of science in the school.*

However, even for those schools which have recorded excellent or good laboratories, there are very few which have a consistently high standard. The pattern is generally that some laboratories have been upgraded or newly built, while others remain basic or poor. Again, having new or refurbished laboratories does not guarantee a final good standard. Comments reveal that a lack of expertise and consultation result in unsatisfactory design, while lack of proper funding can spoil good intentions.

Far more comments were made about this aspect of provision.

- *We are lucky that we had a major fire leading to total refurbishment of 6 laboratories. These are excellent. The two that were not fire damaged are in a sorry state. All would be in this condition if it were not for the fire. Pity the fire brigade arrived so early.*
- *We have a new science block. Unfortunately, poor interpretation of plans and requirements meant that only a basic laboratory has been achieved. The budget also has not been allocated in a wise way. … teething problems … meaning the labs have inadequate ventilation.*
- *My chemistry lab was refurbished 5 years ago by XXXX LEA. Problems included:*

    no sink adjacent to teacher's bench,

    teacher's demo bench is too small,

    gas cut-off point is by door – always knocked by pupils,

    window blinds are very difficult to operate – a waste of time.

  It is far worse than the 30 year old lab it replaced.

- *Labs have been refurbished in the recent past – the designs and build are both – well – horrid …*
- *Easter 2001 we (achieved) a refurbished lab; organised by XXXX LEA. Autumn 2001 the same lab failed a H&S check; organised by (the same) LEA!*
- *New laboratories recently provided by XXXX as part of a PFI-funded new build to the school are unsafe or unsatisfactory standard. There was no consultation with the school with regard to design. Due to poor design …*
- *All labs were refurbished recently but often not completed:*

  no blackout available

  no whiteboard

  no projector screen

  due to lack of funds to finish the job.

Costs (see *Appendix 2.15*) to upgrade all 7770 good laboratories to an excellent standard, to include an interactive whiteboard and 15 laptop computers
= **£144 000 000.**

Basic standard laboratories

Laboratories at the 'basic' standard (see Criteria, *Appendix 2.1*) allow science teaching and learning to go ahead, but under uninspiring, dull and awkward conditions. Layouts are not flexible, decoration is poor, light levels can be low and ICT is notable by its absence. 40% of laboratories are in this category and this must surely play a part in the well-researched views of pupils that science is 'boring' and irrelevant[21]. Teachers too must be de-motivated by such surroundings. The age of laboratories can also play a part in such a boring, demotivating view of science.

For example:

- *Poor lab design. Old and worn-out fixtures and fittings. Uninspiring. Difficult to work/teach/learn in. … Science as a result of the rooms is seen as old-fashioned/antiquated – not cutting edge.*
- *The standard of laboratories (1960's style) has a profound effect on the students' perception of science. It does not promote it as a cutting edge subject. Poor facilities are demotivating and difficult to teach in effectively. …*

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[21] For example,

Pupils' and parents' view of the school science curriculum, J Osborne and S Collins, King's College London, 2000.

Science Education from 14 to 19. Third Report of Session 2002-02 of the Science and Technology Committee, House of Commons, London, July 2002.

Set for success. The supply of people with science, technology, engineering and mathematics skills. The report of Sir Gareth Roberts' Review for HM Treasury, London, April 2002.

- *The chemistry lab is an appalling teaching environment with no positive features. Designed in the stone age with not the first clue about student needs.*
- *One lab has original 1901 fittings!*

Costs (see *Appendix* 2.15): to upgrade all 10 695 basic laboratories to a good standard = **£321 000 000.**

Unsafe and unsatisfactory laboratories

Many of the criteria for this standard (see Criteria, *Appendix 2.1*) suggest strongly that the laboratories concerned should not be used on health and safety grounds. These include: lack of health and safety equipment, poor standards of ventilation, heat and humidity control, significant damage to floors, benches and services, lack of master controls, poor acoustics, etc.

In addition to health and safety issues, poor design and/or lack of facilities make teaching very difficult.

Many comments were made on poor laboratory provision.

- *[The] LEA recently fitted out a classroom as a lab knowing it was too small, but we were desperate for labs. Others have inter-war/pre-WW1 benches cut and salvaged when two schools combined.*
- *Biggest problem is that our labs are mostly conversions. Too small, too dark, too hot, too sunny. …*
- *… 30 years of grime on walls, ceilings, etc. …*
- *Two laboratories have open sewers / drains. …*
- *Window frames leak in 4 laboratories – water pours in when raining heavily.*
- *One lab is outside [the] main building, [a] former brick store, very small …*
- *High humidity, poor ventilation, no windows in science department, high temperature all day. All [these] affect teaching and learning at this school. No natural light.*
- *Our labs are atrocious in mice-infested buildings …*

Class size bears significantly on the space available in laboratories and the number of pupils for which laboratories were designed. It is worth noting that at the time this report was being prepared, the DfES changed[22] the standard size for new laboratories from 85 to 90 m^2. However, many existing laboratories are well below 80 m^2. Timetables that put large classes into laboratories that were designed for much smaller numbers lead to risk assessments that will limit practical work. Classes over 30 in Key Stages 3 and 4 are common and classes over 20 have become common post-16. The need to reduce class sizes is one of the main reasons for judging that a school has insufficient laboratories overall (see below).

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[22] *Revised Building Bulletin 80*, DfES, 2004. Available only in electronic format at www.teachernet.gov.uk/management/resourcesfinanceandbuilding/schoolbuildings/ or www.ase.org.uk/ldtl/.

The following is a selection from over 70 comments made about laboratory provision and class size.

- *All laboratories are too small. Two … are 63 square metres and 67 square metres.*
- *We have seen a considerable decrease in post-16 results in recent years, predominantly due to the lack of suitable facilities. …*
- *KS4 class sizes up to 34 in some cases – too big for safe … practicals. …*
- *Labs are very small for classes of 24 students. These have been used for 30 students on occasions in the week.*
- *There are far too many students in the rooms at the same time, [eg] 35, which makes teaching hazardous, …*
- *Large classes – 34 in Yr 11 …*

Costs (see *Appendix 2.15*): to upgrade all 6559 unsafe / unsatisfactory laboratories to a good standard = **£361 000 000**

(not including any costs involved in correcting building faults such as leaking roofs, faulty windows, etc).

Shortage of laboratories

	Schools	Labs overall	Additional labs required		Labs per school	Additional labs needed per school
	Nº *a*	Nº *b*	Nº *c*	% *c/b*	*b/a*	*c/a*
Sample, from *Appendix 2.5*	744	5569	785	14.1	**7.5**	**1.1**
For all English maintained schools	3518	26341	3870	14.1	**7.5**	**1.1**

Due to lack of provision, increased pupil numbers and expanded A/S groups, there is a perceived need for more than one extra laboratory, on average, in every school. Oversize classes almost certainly result from trying to fit too many pupils into too few laboratories, as well as laboratories that were undersized in the first place. Better timetabling and curriculum planning may improve matters but more laboratories are certainly needed.

Comments made include the following.

- *We have just had two new laboratories opened. It has taken years to get them. Increasing rolls mean we are now short of space again.*
- *Our KS3 pupils have some (40%) of their lessons in the cookery room!!!. We are trying to get this converted into a dual-purpose room as our school does very little cookery.*
- *The most crucial factor is that 30 lessons per week have to be taught in ordinary classrooms around the school!*

- *I have more than 30 science teacher periods being taught in non-specialist accommodation. …*
- *31 science lessons a week are taught out of labs which means the pupils cannot do practicals. …*
- *Teaching in Art / Language & other classrooms also means a restriction on the use of ICT or even books … The quality of (pupils') experience is down to the luck of their timetable and rooming.*
- *Many AS & A2 chemistry (and biology) lessons are not in a lab at all!*

Costs (see *Appendix 2.15*): to build a conservative estimate of 3518 new laboratories (one per school) = **£510 000 000**.

Lack of fume cupboards

It is normal in laboratories in industry and research for all chemicals to be handled only in fume cupboards. Schools are obviously very far from this and we are not suggesting that this level of provision would be appropriate.

In *Fume cupboards in schools*[23], the DfEE suggested that, whilst occasional access to fume cupboards is needed at Key Stage 3, at Key Stage 4 there should be between 0.5 and 1 fume cupboards per laboratory. As all labs in a department are likely to be used for KS4 teaching, Question 12 in the questionnaire suggested that there should be fume cupboards in at least half of all laboratories used for teaching chemistry in Keys Stages 3 and 4, a conservative suggestion. Even at this level, teachers report that, on average, two more fume cupboards are needed in 63% of all schools (see table below.)

Fume cupboards in schools suggested 2 – 3 fume cupboards in each laboratory used for post-16 chemistry, but again the questionnaire (Question 14) used a conservative figure, suggesting that there should be two fume cupboards in laboratories used for teaching A/S and A2. Of those schools teaching at this level, 81% (42% of all schools) need 2 more fume cupboards (see table below.)

For a full analysis of the questionnaire results, see *Appendix 2.6.* To reach a reasonable level, more than 8000 extra fume cupboards are needed in teaching laboratories, in addition to any needed in prep rooms (see section 2.3.2, below.) Lack of fume cupboards must, of necessity, restrict teacher demonstration, pupil practical work and the learning of higher skills by pupils at A/S and A2 levels.

23 *Fume cupboards in schools. Building Bulletin 88*, Architects & Building Branch, DfEE; London, The Stationery Office, 1998.

	Key Stages 3 and 4				A/S and A2			
	Not enough fume cupboards		Nº req.	Nº extra needed / school	Not enough fume cupboards		Nº req.	Nº extra needed / school
	Nº of schools *a*	%	*b*	*b/a*	Nº of schools *c*	% (as % of all schools)	*d*	*d/c*
Sample, from *Appendix 2.6* = 744	468	63	1037	**2.2**	314	42	704	**2.2**
For all English maintained schools = 3518	2216	63	4876	**2.2**	1478	42	3252	**2.2**

Maintenance is also an issue. Fume cupboards must, under the *COSHH Regulations*, be tested each year. Finance is needed for this and for any repairs that are necessary to bring back up to standard the operation of fume cupboards that fail the test. Mobile fume cupboards can have additional problems and recirculatory (filter) fume cupboards can be extremely expensive to maintain.

Comments received include the following.

- *Owing to lack of fume cupboards, some aspects of the curriculum cannot be done as practicals and this affects especially A/S and A2.*
- *No fume cupboards in any of my laboratories.*
- *No fume cupboard available at all.*
- *We do not have a single working fume cupboard for a split site school.*
- *All (labs) have provision for a mobile fume cupboard, but doors have been built too small to allow it to move. …*
- *We bought two mobile recirculating fume cupboards, neither of which we have used as the insurers recommended we didn't as the flow sensors indicated a lack of flow …. There is currently wrangling going on with the council (over this matter).*
- *We have (just) two fume cupboards in one laboratory. However, they have been condemned and need repairs carried out to the fans.*

Costs (see *Appendix 2.15*): to provide enough fume cupboards to match the conservative suggestion for improvement:

in Key Stages 3 and 4	=	**£20 000 000;**
in A/S and A2 courses	=	**£13 000 000.**

Information and communication technology (ICT)

Including criteria on ICT in the questionnaire in the range for 'good' and 'excellent' laboratories prompted many comments. Most of these reflect poor provision for ICT in science, despite many government initiatives to support

ICT in schools. There is not much mention of Internet access, but this would appear to be because there are few computers regularly available anyway.

Organisations which offer support for science in schools are increasing web-based provision on the assumption that all schools can access this easily. While every school may have internet access, it is obvious that this is not readily available in many science departments.

Comments received include the following.

- *I am pleased to see data projectors and Internet access [as] a key feature of an excellent laboratory and fully endorse this.*
- *No interactive whiteboard … [and only] two digital projectors in the school. Limited access to ICT suites (used for ICT KS4). Very difficult to allow pupils access to datalogging with (only) 1 datalogger in the department.*
- *Lack of adequate ICT facilities causes great frustration to staff. Teachers are trained to use ICT, write it into lesson plans and are then in the situation where they do not have access to the equipment.*
- *ICT provision is very out of date. There is no internet access. No data projector.*

2.3.2 The quality of prep rooms in schools

Results of the data from questionnaires are reported here, along with comments made by science teachers and technicians.

Prep rooms come in many shapes and sizes, from one large central prep room to a variety of rooms and storage areas scattered throughout the department. Therefore this section deals with the set of preparation areas that service the laboratories of a science department, called, for ease of reference, 'the prep room'. The sample has been scaled up for all schools in the table below.

	'Prep Rooms'	Poor		Basic		Good		Excellent	
	Nº	Nº	%	Nº	%	Nº	%	Nº	%
Sample, from *Appendix 2.7*	**706**	150	**21**	304	**43**	223	**32**	29	**4**
For all English maintained schools	**3518**	739	**21**	1513	**43**	1126	**32**	144	**4**

Teachers and technicians gave their opinions of the standards of their prep rooms by using the criteria for laboratories and questions on space and facilities that were on the questionnaire.

Excellent and good standard prep rooms

Standards were regarded as good or excellent in approximately 36% of cases. That is, the space allocated is good, the prep rooms are well supplied with equipment and materials and the environment is kept well decorated.

As with the laboratories, there were fewer comments at this standard.

- *We are fortunately in a purpose-built science block where we were all given time to input into the design of the prep rooms. We know how lucky we are!!*
- *Brand new prep room! Very shiny!*
- *Better than the labs!*
- *… Old prep room has been refurbished and is now pleasant to work in (used to be horrible).*

However, the comments do show an appreciation that such standards are unusual. They also show a determination on the part of technicians to improve whatever situation they find themselves in.

- *The school has a large prep room plus a smaller prep room together with a chemical store room. [Also] a large stock cupboard and a small room which we are converting into a repair shop. All this space is necessary to provide a quality technician service.*
- *Until the summer I had a wonderful prep room. … due to changing demands … it has now been redeveloped into a teaching base. However, the amount of shelving in the lab has increased. I am now evaluating how I can improve this further.*

New buildings are not always the answer, as lack of knowledge by designers or poor financial planning can cause problems.

- *Architects seem to have no guidelines on planning a prep room for use by technicians; ie, concerning height of sinks and worktops, numbers of gas taps, pipework for stills and general storage issues.*
- *Our provision is adequate, but only just. … When the building was completed we discovered that most of the cost cutting had affected the prep rooms and storage areas; eg, shelving not provided as expected and prep rooms with no cupboards or shelves – we had to remove and shift these from the old buildings (ourselves).*
- *New PFI build did not plan for prep rooms … gas not working … no mechanical ventilation of chemical store…*

Basic standard prep rooms

Where prep rooms are just adequate, many different things can combine to restrict the quality of work that is possible. Some lack a fume cupboard, others lack sufficient space, or other facilities such as dishwashers, or ICT. These issues are discussed further below. Some are in poor decorative order or simply dirty. 43% of prep rooms were judged to be in this basic category.

Technicians are often highly praised for working hard to combat such conditions.

For example,

- *Our prep room would not be out of place in a 1950's sitcom!*
- *Lab technicians (particularly senior one – we only have one and a half) work extremely hard, under difficult conditions, to make our lives easier. …*

- *No networked / internet computer. … Full computer facilities would enable techs to … research and (do) … admin.*
- *Although the rooms are not too bad [in] size and are quite well designed they are dirty, tatty and, when we are not too busy to notice, really quite depressing.*
- *… Chemical store is a converted boys' toilet with cupboards salvaged from other parts of the school. The urinal was personally taken out by the lab technician.*

Costs (see *Appendix 2.15*): to upgrade all 1513 basic 'prep rooms' to a good standard = **£45 000 000**.

Poor standard prep rooms

As with laboratories, a significant proportion of the prep rooms described here might well be closed under the *Workplace (Health, Safety and Welfare) Regulations*; just one is reported to have been condemned. Poor ventilation, lighting and heating are commonplace. A lack of space and suitable storage for chemicals (both discussed below) often contribute to unsatisfactory working conditions.

A selection of the many comments about poor prep rooms is given below.

- *At the time of completing the survey, the chemistry prep room has been closed due to health and safety concerns: ie, lack of ventilation, unsafe storage of chemicals and [a] working area with no emergency exit in the event of fire. This situation is causing great problems to teaching staff and technicians; some lessons are unable to go ahead.*
- *(Storage space) = Far too little*
  (Preparation space) = Very cramped
  (Condition) = 1952 vintage!
  (Accessibility) = Dire
- *The prep room and storage [are] very small with inadequate heating, lighting and ventilation.*
- *Prep rooms are cold and seldom redecorated. Lighting is poor, especially in the basement, and flooding occurs at times.*
- *Again, the prep rooms are horribly overcrowded. … No working fume cupboard. Storage areas are often far from the prep room. … Building … not [been] redecorated for 20 years. … Greenhouse attached to building is rotting and falling down. …*
- *… We have lost four storage areas in the last two years, only to be given a storage area on the roof (three floors up), which has a roof that leaks. … The only other storage area for equipment is on the ground floor below sewage pipes for the toilets. The pipes frequently leak [and] overflow, covering equipment and stationery with raw sewage. …*

Costs (see *Appendix 2.15*): to upgrade all 739 poor prep rooms to a good standard = **£44 000 000.**

Space for storage and for preparation work

Storage space	'Prep rooms' (= Replies)	Poor		Basic		Good		Excellent	
	Nº	Nº	%	Nº	%	Nº	%	Nº	%
Sample, from *Appendix 2.8*	706	128	**18**	315	**45**	226	**32**	37	**5.2**
For all English maintained schools	3518	633	**18**	1583	**45**	1125	**32**	183	**5.2**

Preparation space	'Prep rooms' (= Replies)	Poor		Basic		Good		Excellent	
	Nº	Nº	%	Nº	%	Nº	%	Nº	%
Sample, from *Appendix 2.9*	706	169	**24**	296	**42**	209	**30**	32	**4.5**
For all English maintained schools	3518	844	**24**	1177	**42**	1055	**30**	158	**4.5**

A major problem in a significant minority of departments is the lack of space to store chemicals, materials and equipment, or actually to work on the apparatus needed for lessons. Lack of planning and an understanding of prep room activities in the original design accounts for many of the problems here but there are other issues. Rising pupil numbers and increased curriculum time for science (including moves into A/S and A2 teaching) mean that space that was sufficient to start with becomes totally inadequate. Schools that reorganise their accommodation sometimes remove store rooms, even actual preparation areas, to create teaching bases, offices, reprographics rooms, etc thus adversely affecting provision for practical work in science.

Many comments have been made, all in a very similar vein and a sample is included below.

- *We have a lack of space …*
- *Poor prep room size limits …*
- *The technicians work in a cramped area with only the most basic facilities (self-made) …*
- *Prep room [was] mistaken for a corridor by OFSTED inspectors!! …*
- *Cupboards are classed as prep rooms…*
- *Poor building design and the later addition of a lift have reduced preparation rooms to small areas remote from main areas …*
- *Prep space has been reduced due to storage of computers, TV/video players …*
- *In the last few years we have lost two prep rooms; one to make a new lab and one to make a fire exit corridor – never used in fire drills.*

- *Access to the school roof is via one of my prep rooms. For the past six months I have had a ladder in the middle of a very small area to allow workmen to access the roof for refurbishment…. A store room has been reassigned from science to admin because 'they need the space'.*
- *The prep room has not changed since I started work here 7 years ago, either in [the] provision of space or decoration, despite the number of pupils doubling in size and including [increased work at] A/S and A2 levels. …*

The relationships between teachers and technicians also bear on the availability of space. There can be no doubt that teachers need space in which to prepare, mark and try out experiments or demonstrations. The design of departments should include sufficient space for the work of both teachers and technicians to work. However, it would appear that not all departments try to manage the use of scarce prep room space to everybody's benefit.

For example,

- *The prep rooms would be adequate … However, they are used by teachers as a dumping ground and as a place to work.*
- *Despite repeated requests, [the] main prep room [is] used as a science staff room (coffee, marking, prep work). We are considering installing [a] lockable 'stable' door!*
- *All but two prep rooms have been taken over for use as teachers' offices / workrooms, therefore …*
- *The quantity of prep room space would be 'good' if the room was not also used as a departmental staff room.*

Chemical stores

The storage of hazardous chemicals can be a difficult problem in any science department. With existing buildings, a compromise is only to be expected but sometimes chemical storage is not considered when planning and designing new accommodation.

For example,

- *Flammables are stored in one of the prep rooms and the fumes can be irritating at times. …*
- *[A] bid [was] made three years ago for a separate, ventilated chemical store. Corrosive chemicals [are] still kept in [the] prep room – rusting cupboards and damaging computer switching box.*
- *Outside storage for chemicals is inadequate and dangerous …*
- *[Accessing] our bulk / flammables store involves two locked doors, one locked gate and a 'key pad' controlled door – two self-closing doors and a flight of stairs. It's a nightmare!!*
- *We have a specially-designed chemical store (built four years ago) which has no fume-extraction facility. This plan was made and passed by the LEA – perhaps they don't know H&S regs?*

Costs (see *Appendix 2.15*): to extend 'prep rooms' in 24% of all schools by 20% of floor area = **£24 000 000.**

Accessibility

The one area of reported success is in the position of prep rooms within the overall design of the science department. Accessibility is judged good or excellent in over 65% of all replies.

Accessibility	Nº overall		Poor		Basic		Good		Excellent	
	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%
Sample, from *Appendix 2.10*	705	100	82	12	168	24	370	53	85	12.1
For all English maintained schools	3518	100	422	12	844	24	1864	53	426	12.1

In the smaller percentage of departments where there are failings in the design or redesign of departments, it is often in the spread-out nature of the provision of laboratories and prep rooms, with little or no thought being given to the consequences, nor extra provision made when problems are brought to light.

For example,

- *Science block on three floors – prep room and chemical store on middle floor – so [there is] much movement of equipment up and down stairs.*
- *Building new labs at a distance from [the] existing prep room resulted in logistical difficulties with transporting equipment.*
- *We have a split site – two labs are across the playground.*

Fume cupboards

Fume cupboards	Schools = 'Prep rooms'	Prep rooms lacking fume cupboards	
	Nº	Nº	%
Sample, from *Appendix 2.11*	744	367	49
For all English maintained schools	3518	1724	49

Scaled up to the full population, the statistics show that nearly half of all departments lack a fume cupboard in the 'prep room'. This makes working with hazardous chemicals very difficult. It may limit practical activities within the curriculum or put at risk the health and safety of technicians.

Costs (see *Appendix 2.15*): to provide a fume cupboard in 1724 prep rooms = **£8 000 000**.

Dishwashers

Dishwashers	Nº Schools	Prep rooms without dishwasher	
		Nº	%
Sample, from *Appendix 2.12*	744	272	37
For all English maintained schools	3518	1302	37

Scaled up to the full population, the statistics show that over a third of all departments lack a dishwasher in the 'prep room'. Washing up apparatus is a time-consuming job and technicians could support the science curriculum much more effectively if all departments had a working dishwasher.

Costs (see *Appendix 2.15*): to provide a dishwasher in 1302 prep rooms = **£6 000 000**.

Lifts

Lifts	Nº schools	School with no lifts that need one	
		Nº	%
Sample, from *Appendix 2.12*	703	276	39
For all English maintained schools	3518	1394	39

Scaled up to the full population, the statistics show that about 1394 schools need lifts and do not have them; that is, 65% of schools that have laboratories on more than one floor do not have lifts.

Technicians spend much of their day moving equipment, chemicals and other materials between laboratories and prep rooms. If these are on different floors there are greater risks. A risk assessment carried out under the *Management of Health and Safety at Work Regulations* or the *Manual Handling Operations Regulations* would probably suggest using trolleys to move equipment and therefore a lift or hoist is necessary to move them between floors. Government initiatives on 'inclusion' also make the provision of passenger-carrying lifts important. A combined (and almost certainly cheaper) solution would be to use standard passenger-carrying lifts for the science equipment rather than installing specialised hoists.

Costs (see *Appendix 2.15*): to provide a lift in all science departments that need one, ie, a one-floor lift for each of 1372 schools at least **£27 000 000**.

(This would obviously be higher if more than two floors were involved, or the passenger lift was so far away from science that a hoist is needed as well.)

2.4 Final Comments

Returns from the questionnaires raise concerns about the number and quality of laboratories and prep rooms in schools.

- Many comments show a great depth of feeling about the environment in which science teachers and technicians work. If teachers have poor perceptions of their working environment it is likely that pupils will have similar perceptions. In turn, this will be reflected in the numbers opting for science post-16 and at university.
- At the worst end of the spectrum, staff and pupils experience conditions that are detrimental to their welfare and quite possibly breach health and safety requirements: low light levels, high heat and humidity levels, lack of heat, even areas contaminated with sewage or by vermin.
- 35% of laboratories are of good or excellent quality but many science departments lack space for all pupils to have their lessons in a laboratory. Would it be surprising if science graduates were reluctant to choose teaching as a career?
- Technicians undertake skilled work. If, in addition to low levels of pay, they have to put up with inadequate space and poor facilities, why should anyone wish to take up, or continue in, this role?

We cannot expect science teachers and technicians to be well motivated and raise the standards of pupils' learning if the majority of science laboratories and prep rooms are uninspiring, unsatisfactory or even downright unsafe or unhealthy to work in. This in turn is likely to affect pupils' perceptions of science, their career choices and especially their view of working as a teacher or a technician in schools.

2.5 Addendum

In the closing stages of compiling this report, the final report[24] evaluating the £60 000 000 allocated by the DfES, from Capital Modernisation Funding, to improve school laboratories was brought to our attention. This independent evaluation, by PricewaterhouseCoopers, confirms many of the issues raised in the current report and emphasises how long standing some of the problems are.

The £60 000 000 was intended for the 'improvement of obsolete school science laboratories' over the period 2000 – 2002. That this was insufficient funding is shown by the results of the current survey. The original DfES funding was intended for around 400 schools, but, in the event, was spread over more than 900 schools. As a consequence, the average funding per school was about £66 000, which compares to the DfES's own figures (*Building Bulletin 80*, 1999), at the time, of £145 000 to build a new laboratory and between £33 000 and £51 000 to refurbish just one laboratory. Therefore, it is not surprising that the

[24] *Evaluation of Science Laboratory Funding*, DfES, Final Report, Nov 2003, being an independent evaluation by PricewaterhouseCoopers of the £60 000 000 allocated to LEAs in 2000-2002 to improve school laboratories.

report states 'Schools and local authorities viewed the amounts of funding they received as insufficient to address historic under-investment'.

The evaluation report questions the management of the funding, stating that 'some authorities did not follow DfES guidance to target the need, and instead allocated the funds relatively widely'. The amount of funding given to any one school was 'relatively modest', resulting in trade-offs where improvements in infrastructure, for example, meant that advanced equipment could not be purchased. Alternatively, '… a new build project had little or no funds left over to make additional improvements … e.g. new equipment ... (for) … innovative teaching techniques.' The suspicion must therefore be that the money was spread widely in order to address problems in as many schools as possible; resulting in the improvements being only to a basic rather than a good or excellent standard (as defined in this report). This wide spread of funding also showed in the minimum amount allocated to any one school. This was very variable, the minimum ranging from £1 000 to £18 000. Even the £18 000 is unlikely to have done much more than provide basic safe conditions. £1 000 is so small that it might just provide a coat of paint or alter one doorway, hardly what was envisaged for the original funding.

The poor situation in 2000 was apparent enough to justify the allocation of £60 000 000. However, the report states that LEAs and schools had identified problems long before and that a 'backlog of need had built up'. One LEA is quoted:

> *Our total capital grant for this scheme was approximately three quarters of a million pounds; the total number of bids which we received from schools was nearly five times the allocation.*

Information provided by OFSTED is said to have suggested that there were 1 000 laboratories in need of funding at the time. The wide spread of funding is stated to have resulted in 1 942 laboratories being funded. The current survey suggests that both figures are woeful underestimates of the work needed to improve school laboratories. Currently, we estimate that 6 560 laboratories remain in the unsafe / unsatisfactory category, while a further 10 695 are basic and uninspiring.

Qualitative evidence in the evaluation report points to the funding being focussed on health and safety issues. These issues had already been raised as concerns by schools and LEAs and so were made top priority for the funding. At first sight this is correct, but dealing with asbestos, fire-hazards, trailing wires and the like might be considered as high priority, whole-school issues that should have been dealt with long before. Using laboratory improvement funds in this fashion might point to desperation and it would certainly result in inadequate improvements to provision for science education.

Case study schools 'expressed an element of frustration at not being able to become more involved in the decision-making process' when LEAs were making project choices. Some of these schools were convinced that they would have been able to achieve more value-for-money, and also further improvements, if they had been more involved. One case study school reported:

> *The school attempted to provide advice on what was needed within the school but the LEA reflected no aspect of this in the project.*

Involvement of the end-user in design, development and implementation has been shown[25] to produce better internal design of the whole school and also of specialist areas such as laboratories.

The evaluation report also supports the current survey and its conclusions on the positive aspects of improving the standards of school laboratories. It points to improved teacher morale and marked rises of pupil interest in science subjects. One case study school reported:

> *Teachers are expressing a renewed pride in their role as educational facilitators, while pupil confidence levels in their approach to science based subjects has improved greatly.*

Innovative teaching methods also showed an increase. However, significantly better improvements were generally found only in those schools which had the (relatively) larger amounts of funding.

Finally, it should be noted there is no reference at all in the evaluation report to any funding being spent on preparation areas. Prep rooms are vital to the functioning of science departments and the current survey estimates that £146 000 000 would be needed to upgrade accommodation to a good standard in this area.

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[25] *Laboratory Design for Teaching and Learning* a national project, managed by the Association for Science Education, funded jointly by the Royal Society and the National Endowment for Science, Technology and the Arts (www.ase.org.uk/ldtl/).

3 Resources Project Report

3.1 Introduction

Science departments must be adequately funded in order to ensure that science is taught effectively to pupils aged 11 to 18. This report is based on an investigation into the current funding of science departments and the cost of providing sufficient suitable resources.

The current funding situation has been explored through a questionnaire sent to about half of the maintained secondary schools in England. The cost of providing sufficient suitable science resources has been estimated through updating and extending a 1997 Royal Society document[26].

3.2 Survey of Science Department Funding and Needs

This part of the investigation was to ascertain the income which science departments actually receive, the uses to which they put the funding and the main areas of need. These issues were investigated through a questionnaire (see *Appendix 3.1*) and the results analysed.

The questionnaire, which had been trialled with a small sample of schools, was circulated to 1654 schools, approximately half of the maintained schools in England with pupils aged 11-16, 11-18 or 14-18; (unlike the Laboratory Project, middle schools deemed secondary were disregarded in this project). The questionnaire was sent to schools in 148 different LEAs which included schools in equal numbers of low-, medium- and high-spending authorities (see section 1.1.3). The actual numbers of schools in each of these latter three categories is not, however, equal since generally lower-spending LEAs tend to have larger numbers of schools. The results were analysed according to the type of schools, their status and pupil age range.

Returns were received from 433 schools representing a return rate of over 26%, which is very high for this kind of survey, perhaps an indication of the high level of concern about funding in science departments. The summary of returns shows that there was an appropriate balance in the type of schools (community, foundation etc), the age range (11-16, 11-18, 14-18 etc) and the nature of the intake (comprehensive, grammar, secondary modern, etc). (See *Appendix 3.2*.)

The questionnaires were mainly completed by a senior member of the science teaching staff although just under one third were completed by a (senior) technician.

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[26] *Science teaching resources: 11 – 16 year olds*, London: The Royal Society, 1997.

3.2.1 Science department funding allocations

The overall funding for science departments in the current and previous financial years is presented in the table below. A more detailed breakdown, by types of school and LEA, is given in *Appendix 3.3*.

	Average sum Total (to nearest pound)	Range in total sum		Average per pupil	Range in sum per pupil	
Current financial year allocation (2003 – 4)						
All schools	£10 560	£1 030	£40 000	**£9.89**	£0.64	£71.43
11 – 16 schools	£7 683	£2 000	£19 000	**£8.78**	£2.96	£18.47
11 – 18 schools	£12 374	£1 030	£40 000	**£10.66**	£0.64	£71.43
Last financial year allocation (2002 – 3)						
All schools	£10 483	£1030	£47 000	**£9.83**	£0.64	£51.65
11 – 16 schools	£7 712	£2 500	£17 615	**£8.82**	£3.16	£20.72
11 – 18 schools	£12 198	£1 030	£ 47 000	**£10.49**	£0.64	£51.65

The survey shows that the average sum available to be spent on *all science items* in the current financial year (2003-2004) based on all schools with pupils in the 11 to 18 age range is **£9.89 per pupil**. This has stayed almost exactly the same as the figure of £9.83 per pupil available in the previous financial year (2002-2003) despite rising prices. Indeed it is not much different to the figure of £9.40 reported in 1998[27], admittedly from a smaller survey (see section 1.2.1). Certainly the figure has not kept pace with inflation.

The average allocation for pupils aged 11 to 16 (derived from the 11-16 schools in the sample) is **£8.78** per pupil per year whilst that for pupils in the 11-18 schools is **£10.66** per pupil per year. Note that this is £10.66 per pupil on roll. Some of those in the 6th form will not be studying science but some will be studying two or even three sciences. It is not surprising that schools which have pupils aged 16 to 18 have higher allocations because it is more expensive to provide an appropriate science education for older pupils who have to carry out far more practical experiments and investigations on an individual basis, using more elaborate equipment or more costly chemicals, than younger pupils. Where expensive equipment needs to used in Key Stages 3 and 4 it will often be demonstrated but this is not an option post-16. However, most schools do not make a clear distinction between the spending for pupils aged 11 to 16 and 16 to 18 since much of the simple apparatus will be shared between the two age groups. Whilst it is not therefore possible to give exact costs for the science education of pupils aged 16 to 18, it is reasonable to say

27 *Science teaching resources: 11 – 16 year olds. The Survey Findings*, P Ramsden, *Education in Science,* 180 (November 1998), pp 19 – 21.

that schools recognise that the cost of providing effective science teaching and learning is greater post-16. An estimate of how much more schools provide is derived in section 3.3.8.

Grammar schools generally have a higher allocation for science per pupil than other types of school (£16.20 on average compared with £9.32 for comprehensive schools). However, this may simply reflect the fact that a higher proportion of the pupils are post-16. Moreover, the gap between the average allocations per pupil for each of these types of schools has widened over the past two years. Voluntary-controlled schools also tend to have higher than the average allocations per pupil (£11.40) although it is not clear why this should be.

It is remarkable that the absolute funding per pupil in the current year varies so widely between schools from **£0.64** to **£71.43**. The gap has widened since last financial year when the range was £0.64 to £51.65. Even in specialist schools (all ability) the range is almost as great, going from £1.08 to £71.43.

To put these figures in perspective, if a pupil in a school with one of the lower allocations dropped and broke a small 100 ml glass beaker costing approximately £1, this would represent more than the **whole of the annual allocation of science funding for that pupil**. The cost of many of the science textbooks for Key Stage 3 and 4 pupils would use the full amount of **average** funding for that pupil per year even before teaching, including demonstrations and practical work, was taken into account. Post-16 science text books typically cost more than an average per pupil allocation.

Whilst there are variations depending on whether the schools are in lower-, medium- or higher-spending LEAs, these do not show clear-cut patterns. In the last two financial years, schools in high-spending LEAs have received more funding per pupil on average than those in medium- or low- spending LEAs. However, in both the current and previous financial years, the average annual sum allocated per pupil in science was lower in medium- spending LEAs than in low-spending LEAs. That in low-spending LEAs was in any case very close to the average figures for all schools as shown in the abbreviated summary below. Some apparent inconsistencies between average sums allocated and average sums per pupil are probably because school populations vary between years. (See *Appendix 3.4* for full table.)

Type of LEA	Average sum total (to nearest pound), current financial year (2003 - 4)	Average per pupil current financial year (2003 – 4)	Average sum total (to nearest pound), last financial year (2002 – 3)	Average per pupil last financial year (2002 - 3)
Low-spending LEAs	£10 437	**£9.89**	£10 237	**£9.62**
Medium-spending LEAs	£10 439	**£9.58**	£10 405	**£9.49**
High-spending LEAs	£11 018	**£10.66**	£11 114	**£10.84**

3.2.2 Adequacy of science department funding allocations

It is clear that, in a substantial majority of schools, the current levels of funding are inadequate to sustain an effective level of science education.

Schools taking part in the survey were also asked for their judgements on the adequacy of funding. Over 90% of the schools responding judged that the current funding for science was insufficient to enable them to provide effective and challenging science lessons. The overall outcome is shown below. (See *Appendix 3.5* for the full table.) Only in the two specialist schools with restricted ability did this figure reduce significantly to 50%. Even in grammar schools, which are better funded on average, the percentage of schools which felt that they received sufficient funding to enable them to provide an effective science education was only just over 14%. There is therefore remarkable unanimity between schools on this issue.

Sufficiency of funding	Sufficient funding to provide an effective standard of science education	Insufficient funding to provide an effective standard of science education
All schools	9%	91%

It might be argued that few departments would readily acknowledge that they are adequately funded. However, respondents backed up their judgements by identifying quite specifically where the impact of significant shortfalls in funding was affecting equipment provision. These areas of shortfall are identified in the section below which refers to areas of need.

The overall judgement by schools was almost always accompanied by a comment. For every comment such as:

- *The budget is OK except for large items, eg, ICT and sets of books.*
- *Can't grumble.*
- *We have sufficient funding.*

there were nine or ten which reflected the opposite view.

- *When a class of A-level students doing A2 coursework has to share a colorimeter then real problems occur and it is a poor reflection of science education.*
- *Funding is insufficient for sections of the National Curriculum to be taught effectively.*
- *The school provides as much as it can but doesn't get enough (overall) to provide more.*
- *We had a situation 2 - 3 years ago where funding (just) met our needs. Our bid has had to be realistic for the last 2 - 3 years and this has meant cutting corners. We are just seeing the effect of this …*

- *We are constantly cutting corners - unable to send staff on courses at present*
- *… practicals are removed because of lack of equipment.*
- *We spend less money on equipment than we do on external assessment.*
- *Equipment orders have really suffered (over the) last five years.*

In schools with pupils aged 16-18, many of the respondents noted that even though numbers of pupils studying science had increased, the funding had not.

A recent SBS[28] survey of science teachers showed that 65% of those responding judged that funding for large items of equipment was inadequate. Funding for ICT was judged insufficient by 48% and that for consumables by 29%. However, that survey was based on a sample of only 67 schools in 22 LEAs and was not as extensive as the one currently being reported and overall funding was not commented upon.

3.2.3 Sources of funding and systems of allocation

Most schools and colleges allocate the bulk of their funding for science from overall school capitation funding. However, a variety of other sources were identified by heads of science, a significant one being Key Stage 3 funding. Some respondents mentioned other sources of funding including specialist school funding, initial teacher-training payments, e-learning credits, beacon department or school status monies, education action zone funds and parent/teacher associations. A very small number mentioned specific local initiatives such as a school links programme with local industry and a gifted and talented programme. Sums in these latter categories tended to be small, often amounting to no more than a few hundred pounds. By their nature, many of these are short-term grants which may last for between one and three years only.

Funding from the Learning and Skills Council (LSC) was mentioned by some of the schools and colleges with post-16 pupils but seems to have had little impact on improving funding for science. Only 11% of the 243 schools in the sample responding felt that the advent of LSC funding had altered their funding significantly. An even smaller percentage (2%) indicated that funding had definitely improved subsequent to LSC funding. (See *Appendix 3.6.*)

In the vast majority of cases the basic allocation is made either through a school-based formula (55%) or a combination of a formula and a departmental bid based on estimated running costs (36%). (See *Appendix 3.7* for a more complete breakdown.)

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[28] *SBS Survey of Secondary School Science Teachers*, SBS (The Save British Science Society), London, January 2004.

	School formula		Annual departmental bid		Combination of formula and bid	
Allocation of funding	Number of schools	% of total	Number of schools	% of total	Number of schools	% of total
All schools	229	55	47	11	150	36

In a typical school the total amount of money available for running subject departments is divided amongst them using a formula involving the number of pupils studying the subject (N), a weighting for the age of the pupils (Y), the number of periods on the timetable (p) and a weighting for the subject. In some schools, the latter may be quite sophisticated, with elements for equipment (e), textbooks (t) and consumables (c). The formula would then be as follows[29].

$$\text{Departmental allowance} = N\,Y\,(pe + t + pc)$$

e and c might be high (eg, 3) in science and technology, low (eg, 1) in languages, whereas t might be 3 in English, 2 in science and 1 in art. Many respondents made the point that science departments make sensible estimates of the funding they need simply to maintain the status quo, let alone improve the situation, but their bids are then reduced because the money is simply not available.

- *This year we calculated we needed £18 000 to cover science needs but were given £10 500 so departmental bids [are] not much use!*

In those schools where money is available, bids might also be accepted later in the financial year. The responses indicate that there is now less chance of a "top-up" bid being an option later in the financial year as happened more frequently in the past. Indeed, returns indicated that, in a significant number of schools, such options are no longer open because the school is operating a deficit budget.

Many of the returns made the point that it is not only the lack of adequate funding which is causing problems but the uncertainties caused by variations from year to year and the short-term nature of specific grants which make longer-term planning almost impossible. This is of considerable importance where science departments need to replace major and expensive items of equipment or full sets of text books to meet the changing needs of examination specifications, or even to maintain the *status quo*.

3.2.4 Departmental uses of funding in science

As noted above, just under 10% of returns indicated that the funding met the needs of the science department and was not an inhibiting factor in the quality of science provision. However, most returns clearly identified areas

29 *ASE Secondary Science Teachers' Handbook*, R Hull (ed.), Hemel Hempstead, Simon & Shuster Education, 1993. ISBN 0 7501 0449 X.

where the money allocated was spent and those where there were significant shortfalls.

The obvious areas of expenditure in science departments (which encompass at least three different science disciplines) are basic scientific equipment and consumables. School responses indicate, however, that funding in the vast majority of science departments has to cover a much wider range of items. The list below identifies the main items which senior management expect to be covered by departmental budgets. The percentage figures indicate the proportion of schools to which each item applies.

- Textbooks (97%)
- Health and safety equipment (96%)
- Capital equipment replacement (94%)
- Printing and photocopying (93%)
- ICT software (88%)

This is not, however, the limit of the range of items which science budgets are expected to cover. Between almost a half and three quarters of the schools indicate that the following items also have to be covered.

- ICT hardware (55%)
- Laboratory support equipment replacement (75%)
- Annual equipment maintenance charges (49%)
- Annual service subscriptions (such as CLEAPSS and ionising radiation protection advisers) (56%)
- Professional body subscriptions (48%)

(See *Appendix 3.8* for a full listing.)

It is not surprising that budget allocation was identified as being the most significant factor in limiting the quality of work in science. However, other factors of high priority impacting on the quality of science teaching and provision were identified as being:

- class size,
- laboratory accommodation (sufficiency, quality and occupancy levels),
- provision of technicians,
- provision of suitably qualified teaching staff and
- access to ICT facilities.

(See *Appendix 3.9* for a more complete breakdown.)

The small-scale SBS survey mentioned above also identified lack of funding, inadequate laboratory accommodation and pupil behaviour as major factors inhibiting practical work in particular.

3.2.5 Departmental areas of need in science

The survey highlighted the *major* areas of resourcing on which present shortfalls in funding are having an adverse impact on the quality of science education. The list below is broadly in rank order.

- ICT hardware and equipment
- Replacement of large items of equipment (some of which were identified as being 40 years old)
- Purchase of new large items of equipment needed to keep provision up to date and in line with specification requirements
- Text books
- ICT software
- Basic science equipment

All of the above were mentioned by between three quarters and one half of the total number of replies. A more detailed breakdown is given in *Appendix 3.10*.

Also mentioned as being areas of *significant* shortfall were:

- ICT consumables,
- photocopying and printing,
- videos,
- consumable items (such as chemicals) and
- written resources for teachers.

All of the latter group of items was mentioned by at least 25% of the respondents.

When asked to select a top priority for a single sum of funding, schools gave comprehensive responses, the summary extending to 17 sides. The top choices were as follows.

- Upgrading and extra provision of laboratories
- Enhancing ICT hardware provision and access
- Improving ICT facilities such as dataloggers, sensors, interactive white boards etc
- Text books
- Replacement of major items of equipment and buying new more up-to-date equipment (extensive mention was made of balances, power packs and other electrical equipment, microscopes etc)
- Ensuring provision of basic equipment

Also mentioned were provision of enough suitably-trained staff to try to ensure effective teaching and reasonable class sizes, and sufficient, suitably-trained, technician support.

3.2.6 *Issues relating to information and communications technology (ICT)*

This is an aspect of school and college science which clearly continues to concern many science departments. Some respondents provided a picture of good access to suitable and up-to-date ICT facilities, with interactive white boards available for day-to-day teaching, a good range of equipment such as dataloggers and sensors, adequate software and an effective and prompt maintenance system.

However, this represented the situation in only a minority of schools, most reflecting concerns that they were not adequately meeting curricular requirements with respect to the use of ICT in science. 25% of returns showed no immediate availability of desktop computers to pupils in science lessons and 64% no ready access to laptop computers. It is worth noting that it is mainly ICT provision which distinguishes Excellent Laboratories from the merely Good, in section 2 of this report.

As with capitation, there was wide variation between schools. The number of desktop computers available to science ranged from 0 to 120 with an average in all schools of about 8. The number of laptops available to science ranged from 0 to 62 with an average of about 4.5. The average number of pupils per desktop overall was 133, whilst the average for laptops was 267. In general pupils in 11 to 16 schools (and those in grammar schools) are better provided with desktop computers than other types of school.

In some establishments there is additional access to ICT facilities elsewhere in the school but the general view was that such facilities are in heavy demand from other subjects. See *Appendix 3.11* for a more complete breakdown.

Teaching staff and technicians also need access to computers. On average, staff have access to 2.19 desktop computers and 2.46 laptops. However, this average figure hides the fact that over 10% of science staff in schools have no access to any desktop computers and over 35% have no access to any laptops.

See *Appendix 3.12* for a more complete breakdown.

The questionnaire also sought information about ICT networks. 100 schools have no networking in any laboratory and 148 have all laboratories networked. The remaining 163 have varying percentages of laboratories with a degree of coverage. Overall, slightly more than 50% of laboratories of schools in the survey have been networked. In general, foundation, voluntary-aided and grammar schools are more completely networked than other types of school.

Number of schools with networked laboratories	**None**	**Some**	**All**
All schools	100	163 ranging from 7% to 90%	148

A full breakdown is shown in *Appendix 3.13*.

Where schools have been able to network science laboratories, usage is often limited by insufficient up-to-date computers and often by lack of equipment such as dataloggers and sensors.

Computers are quite often gifts from other sources and are sometimes not very up to date or reliable. Maintenance is mainly carried out within the school, through an LEA workshop or through maintenance contracts. However, a frequent comment was that computers are often out of action for extended periods of time, thus making regular use difficult.

Despite significant progress in ICT provision in science over the last few years, the overall provision is still below that required to ensure appropriate use in science lessons and a school's ability to meet curricular requirements. The variation between schools is as of as much concern as the overall average provision.

3.3 Science Resource Requirements and Their Costs

In this context, it should be noted that the expression 'science resource requirements' includes not only apparatus but also chemicals, living or once-living organisms and relevant services such as maintenance.

In 1997, the Royal Society published *Science Teaching Resources: 11 to 16 Year Olds* which was an updated version of an original 1990 document. The list became an essential reference for those equipping science departments. It was costed, thus enabling conclusions to be drawn about actual costs of providing a minimum level of resourcing with which to teach science to 11 to 16 year old pupils effectively.

3.3.1 Changes to science education since 1997, the revision and extension of the list and funding available to science departments

Much has changed in science education since 1997. There is greater emphasis on continuity with Key Stage 2, there is an even greater emphasis on practical and investigatory science, the expected use of ICT has increased substantially, the AS and A2 examinations have been introduced and there is a wider variety of courses including those with a vocational bias. Much emphasis is being placed on continuity within the curriculum 14 to 19. There are other significant changes including the ageing of laboratory provision, the increasing difficulty in recruiting science teachers and financial restrictions which have also impacted on the provision of trained technicians.

For this project, the Royal Society science resources list of 1997 has been revised by the consultants involved in the project. It has also been extended to encompass provision for 16 to 18 year old pupils and the combined lists recosted to take account of the above changes as well as the increase in prices of many items.

3.3.2 Criteria for inclusion in the resources list

The criteria for inclusion of resources and materials in the list remain the same as in the previous Royal Society lists. The major criterion is that the item is necessary to teach effectively the science National Curriculum or the AS and A2 levels or their vocational equivalents. In some cases, items are included to enable teachers to provide first-hand practical experience essential to a good science education. Using a secondary source such as a video is suggested only where practical work would be unsafe or where apparatus is too complex for school use. Items included in the original document were cross checked against a variety of published schemes. This revision has not attempted to ensure that every resource item required to teach all published schemes would be included. Nevertheless, all schemes which can be used to meet the requirements of the National Curriculum and the awarding body specifications should broadly be catered for.

As indicated in section 1.3.2, resource lists for post-16 were not included in the original report. Lists have been compiled for this report by taking three leading and highly-respected specifications, one each in biology, chemistry and physics, and costing their resource requirements. Whilst this is less rigorous than the approach adopted for 11 - 16, these are all considered to be quality schemes, setting a standard to which others should aspire. The three specifications were chosen because they had a well-developed package of support materials from which it was possible to identify resource requirements. All three were the result of curriculum development projects: Salters' Nuffield Advanced Biology, Nuffield Advanced Chemistry and Advancing Physics (Institute of Physics). In the case of chemistry, the costs of the Nuffield Special Studies were not included (as these are atypical and the costs vary considerably depending on the study chosen). However, some chemicals and equipment needed for most syllabuses, but not explicitly specified in Nuffield, were included. Also, at the time this work was done, the Salters' Nuffield Advanced Biology was still under development and we relied on trial materials rather than the final published scheme, which may differ slightly. Choosing other specifications for any of the subjects would alter some of the details of the lists and the costs but the view of the professionals involved was that the total costs would be little different.

As in the 1997 Royal Society lists, the "Essential" column represents the absolute minimum number of items in order to carry out meaningful and effective practical science in accordance with the requirements of the National Curriculum or post-16 courses. The choice of quantities identified has erred on the side of caution so that the "Essential" list is an absolute minimum. The "Desirable" column is by no means a luxury list and includes only items commonly used successfully to increase pupil interest, motivation and understanding in schools which are fortunate enough to have them.

The items shown in the post-16 sections are those required over and above those identified as "essential" in the 11 to 16 lists. Therefore an institution teaching only post-16 students would need to add the relevant items from the

11 to 16 section in order to teach the subject effectively, although we have not considered such institutions in this report. A school that had a significant proportion of the "desirable" items in the 11-16 lists would need to spend less on its post-16 students than we have identified here.

3.3.3 Assumptions made about school sizes and class sizes

Schools vary in size. In order to provide a baseline for calculation, quantities in the lists are mainly based on a "number per laboratory (essential)". Some items would not necessarily be used in each laboratory so a "number per school (essential)" and "number per school (desirable)" have been included additionally to allow calculations of costs to be worked out for schools of different sizes. The 1997 Royal Society document indicated that many schools have six laboratories and two preparation areas so a column "Total for a school with 6 labs" has been added to facilitate rapid calculations to be made. Since the calculations have now been extended to include pupils aged 16 to 18, it is likely that *one or more additional laboratories* would be needed depending on the size of the 11 to 16 cohort and the number of pupils continuing with science. *No account has been taken of this* in terms of basic equipment per laboratory. To estimate costs for a specific school using the formula, an additional set of basic resources would need to be added. This underlines the earlier statement that present estimates are set deliberately on the conservative side. (It should be noted that the Lab project survey shows that schools have an average of about 7.5 laboratories.)

The "number per lab (essential)" indicates that every laboratory needs one or more of these items. The actual storage location of the items will depend on the school's own layout, organisation, laboratory usage and security.

Certain assumptions have been made in compiling the quantities. These are based on the recent experiences of those undertaking the revision. The main assumptions are:

- a pre-16 class size of 24 for the most effective and safe teaching (however, in many schools class sizes of 30 or even more are common and this has implications for resources needs);
- pairs of pupils working together for practical work pre-16 hence 12 sets of equipment as minimum (or 15 in the case of class sizes of 30);
- a post-16 class size of 20 for AS and 16 for A2 classes (though anecdotally many schools report post-16 class sizes in excess of these figures because there are insufficient laboratories or too few teacher hours available);
- pupils working individually for much of their practical work post-16, hence 16 sets of equipment as minimum (except for physics and biology work where some experiments may be carried out on a rotation basis);
- enough extra equipment to cover breakages or faults judged to be the equivalent of two groups' worth.

The “additional number per school (essential)” is intended to cover items of which schools will need only one or two (eg, water de-ionisers) or where items will not be required in every laboratory.

The “additional number per school (desirable)” is intended to cover items which are not essential in an 11-16 school but would add to the quality of provision of a stimulating science experience and may anyway be needed in an 11-18 school, for example Teltron tubes or cloud chambers in teaching physics. 11-18 schools which have such items offer a richer curriculum experience to their pupils in comparison with an 11-16 school which lacks them.

Where schools are larger or smaller than average, amounts of resources can be scaled up or down by the relevant factor. Note that we have ignored the possibility of post-16 courses other than AS and A2 . There may, for example, be science GCSEs or vocational courses which we have not costed.

Although far from desirable and ***not*** included in the original Royal Society report, for this report it was felt necessary to recognise the reality in many schools by adding a column showing essential items for classes of 30. Some costs are fixed, irrespective of the size of the class. This is mostly the items used by teachers in demonstrations, eg a van de Graaff generator or for whole school use, eg, water stills. Other costs depend on the number of pupils in the class, eg more microscopes will be needed at the same time in a larger class.

Except, perhaps, for some selective establishments, a school with six laboratories is likely to have only one teaching group for each of the three major sciences in each of Years 12 and 13. Where schools have much larger numbers of pupils post-16, amounts of equipment may need to be scaled up to allow for more than one group carrying out practical work at the same time.

3.3.4 Assumptions made about the amount of science taught

The amount of science taught will have some effect on the amount of equipment and materials needed but it is not necessarily a linear relationship.

Less disposable materials are likely to be used if less time is spent on science but this will not be true for equipment. Broadly, the following assumptions have been made.

- Pupils in Key Stage 3 spend at least 12.5% of their curricular time on science (approximately the proportion indicated by statistics).
- Pupils in Key Stage 4 spend 20% of their curricular time on science (although a minority may spend less than this, a different minority follow separate sciences which often takes more time).
- Those pupils staying on post-16, follow courses taking on average about 20% of curriculum time per advanced subject studied.

3.3.5 Costs of resources

The number of items has been based on the school model and criteria identified in section 3.3.3. Clearly, if group sizes are smaller or larger, the number of items of equipment or amounts of materials will change in some cases. However, there will be a minimum for many of the items listed in order to ensure that the specification requirements are met. Where a school is large enough to support several post-16 advanced science groups in each subject, the cost will increase pro-rata for consumable items but not for capital equipment so that there would be some economy of scale (more relevant in physics, less relevant in chemistry). Some variation in amounts required may also arise where the school opts to use pairs or groups of pupils to carry out more specific practical activities than our interpretation of good and effective practice would require. There is nothing wrong with this approach provided that there are sound educational reasons for pupils working together on a specific practical activity and that it is not done purely to reduce costs. Clearly some reduction in costs may occur for this reason. Equally a reduction in costs may be achieved through a carousel arrangement for practical work, thus multiple sets of some items of equipment can be avoided. This can also give rise to reductions in costs but should not be used purely for this reason because learning suffers when there is inappropriate sequencing of theory and practical work.

Each item in each list has been costed, and an approximate lifetime estimated. Lifetimes are based on manufacturers recommendations and the professional judgement of those compiling the lists and writing this report. Sometimes equipment does last longer than expected and this will reduce costs. It is important to include some element of depreciation costs although schools are in fact rarely able to budget for this. Also, syllabuses change and new equipment is quite frequently needed. In any case, it can do little for the image of science if pupils are using obviously ancient apparatus.

The costings can be used, together with the assumptions about class size and numbers in the school, to calculate a cost per pupil. Costs identified are at typical 2004 catalogue prices. A proportion of the costings were kindly provided by Philip Harris Education but costings for most of the items were sought from the catalogues of a range of appropriate suppliers. Schools might be able to purchase individual items from local suppliers or manufacturers at lower prices but it is unrealistic to try to take account of such variations in different parts of the country in this document.

Items listed must also be of sufficient quality to meet the requirements of the *Provision and Use of Work Equipment Regulations 1992* and be offered for sale with a reasonable expectation of continuity of supply.

In some cases bulk-order buying can lead to discounts for orders above a specified sum. Potential deductions of this kind are taken into account by reducing the total sums by 10% for both the “essential” and the “desirable” costs in the calculations for typical schools given below. This may well lead to an underestimate of costs since the reduction of 10% has been made on all items when in reality such discounts are unlikely to apply to the full range of equipment in the list.

3.3.6 Costs **not** *included which are essential to support science teaching*

There are many things which are essential to science teaching and carry significant costs that are *not* included in the resources lists. They fall into two broad categories, materials and personnel.

Materials includes:

- pupil textbooks;
- photocopying, reprographics and printing;
- stationery;
- trays, trolleys and other carrying equipment.

Personnel includes:

- teaching staff;
- technician support;
- teaching assistants;
- development and training.

3.3.7 Lists of essential and desirable resources

The revised list for essential and desirable resources for science pupils aged 11 to 16 is given in *Appendix 3.14* whilst the new ones for advanced courses in biology, chemistry and physics are provided in *Appendices 3.15, 3.16* and *3.17*. The latter assume that the essential (but not the desirable) resources to be found in the school for teaching younger pupils will still be available.

3.3.8 Calculations of costs

The following table summarises the costs of providing resources for an effective science education for pupils aged 11 to 16, whether taught in classes of 24 or 30. For the purposes of comparison, the figures from the 1997 Royal Society report are also quoted.

Annual cost per pupil, 11-16	*Classes of 24 pupils*		*Classes of 30 pupils*	
	Essential only	*Essential + desirable*	*Essential only*	*Essential + desirable*
1997 report	£11.38	£17.28	-	-
This report	£20.58	£29.14	£22.22	£30.75

The cost of providing resources for an effective science education for pupils age 11 to 16 is calculated by dividing the total annual cost for science by 750 which would be the number of pupils in a five-form entry school with 30 pupils per form of entry. Each year group would therefore consist of 150 pupils and the total number of pupils would be 5 x 150 (ie 750). A five-form entry school would require a minimum of six laboratories especially where science teaching group sizes are 24.

The calculations show that the cost of providing science resources to offer an effective science education to pupils age 11 to 16 is **£20.58 per pupil per year for "essential"** resources and **£29.14 per pupil per year for "essential and desirable"** resources where the class size is 24, in each case allowing a full 10% discount. Where the class size is 30 these costs rise to **£22.22 per pupil per year for "essential"** resources and **£30.75 per pupil per year for "essential and desirable"** resources still allowing a 10% discount. Of course, with larger classes, the school will save money on teachers and laboratories, but the resources cost of increased class size is often forgotten. Children in large classes are disadvantaged on several counts: more over-crowded conditions, less teacher attention and fewer resources. It must be recalled that these figures do *not* include the cost of text books, printing and photocopying etc, nor do they include any personnel costs.

The figures show a significant increase over the 1997 costing of essential science resources for pupils age 11 to 16, which was £11.38. The main reason for the increase is because of a much greater requirement now for ICT. In the 1997 figures, £1.68 out of the £11.38 total was due to ICT. The retail price index has increased by around 17% between 1997 and 2004. Applying this figure to the £9.70 *not* due to ICT, would give a figure of about £11.35. However, in the current report ICT contributes £7.58 out of the £20.58 total, ie nearly five times as much as in 1997. The non-ICT component of the current report is about £13.00 (£20.58 - £7.58). This is still higher than the inflation adjusted figures of £11.35 and can be mainly attributed to above-inflation increases in the cost of some chemicals and equipment (despite a few items having dropped in price). Some of this increase is due to a reduction in the number of firms offering equipment, a rationalisation in their catalogues and generally fewer choices for many items. Examples of above-inflation increases include aluminium foil (£2.64 to £8.50, ie 222%), lead(II) bromide (£12.34 to £27.88, ie 126%), sodium hydroxide (£11.95 to £27.88, ie 133%), a microscope (£84.50 to £119.00, ie 41%) and a ray optics and colour-mixing box (£62.21 to £104, ie 67%).

It is less easy to provide an accurate figure for the cost of providing resources for advanced science courses. Sixth-form numbers vary enormously, as does the relative uptake of the different science subjects. Using the exemplar school model with six laboratories, ie 150 pupils in each of Years 7 to 11, it is likely that there will be no more than one group of advanced biology, chemistry and physics in each of Years 12 and 13 (and some schools would struggle to achieve even this). Using the group sizes of 20 in AS classes and 16 in A2 classes employed throughout the model, this would mean that 36 pupils were studying each of the three main sciences at any one time and would give a total number of 108 pupils studying science subjects in the sixth form. (Of course, some pupils will study two or even three sciences and will therefore be counted two or three times in the 108 total but they do need to be counted in this way as the costs depend on the number of science subjects studied.) Typically the numbers are not equally distributed between the three sciences but the model can be adapted according to the actual numbers. The total studying science may well be larger if the school offers human biology and one or more vocational science courses. We have not taken this into account.

It is possible to obtain an estimate of what schools actually allocate to advanced science courses using the model school. The average 11 to 16 school using the model spends £8.78 on each of its pupils per year on science, while the 11 to 18 school spends £10.66. Thus at 11 to 16, typically £6 585 (£8.78 x 750) will be allocated annually. We need to estimate the number of pupils on the total roll of an 11 to 18 school which has 750 pupils in the 11 to 16 age range. In our resources survey, there were 258 schools with post-16 pupils which reported separately on the number of pupils pre- and post-16. These schools had an average of 209 post-16 pupils and an average of 1008 pupils aged 11-16. So we can estimate that a school with 750 pupils aged 11 to 16 will have about 156 6^{th} formers (of course, not all taking science subjects and some taking more than one), ie, in all 906 pupils. At £10.66 per pupil, this gives the average 11-18 school £9 657.96 (£10.66 x 906). Comparing this with the £6 585 for an 11-16 school, it would follow that the additional money spent annually on post-16 science would be £3 072.96. This would be available to spend amongst the 108 pupils assumed to be studying advanced sciences, ie **£28.45** per pupil per year per science subject studied.

Because pupils choose different numbers of science subjects post-16 it is not possible to give a typical cost per pupil for providing an effective science education for this age range. However, it is possible to work out an approximate annual cost for each of the three main sciences post-16 averaged out over a two year course. The figures in the table below are derived from the advanced level subject lists for provision of an effective education with a full 10% discount. (Note that in chemistry, no items were identified as desirable – all were considered essential).

Post-16	Cost per pupil per year averaged over two years ESSENTIAL ITEMS ONLY but allowing 10% discount on all items	Cost per pupil per year averaged over two years ESSENTIAL + DESIRABLE ITEMS but allowing 10% discount on all items
Biology	£34.82	£43.83
Chemistry	£93.78	£93.78
Physics	£296.82	£436.91

3.3.9 Comparisons between actual funding and costs of teaching science effectively

The following tables shows the shortfall in funding for 11-16 and post-16 pupils respectively.

Annual cost per pupil,	*Classes of 24 pupils*		*Classes of 30 pupils*	
11-16	*Essential only*	*Essential + desirable*	*Essential only*	*Essential + desirable*
Amount needed	£20.58	£29.14	£22.22	£30.75
Amount available	£8.78	£8.78	£8.78	£8.78
Shortfall	£11.80	£20.36	£13.44	£21.97

Estimated national shortfall	£34 million	£59 million	£39 million	£64 million

Post-16	*Cost per pupil per year averaged over two years ESSENTIAL ITEMS ONLY but allowing 10% discount on all items*			*Cost per pupil per year averaged over two years ESSENTIAL + DESIRABLE ITEMS but allowing 10% discount on all items*		
	Amount needed	Amount available	Shortfall	Amount needed	Amount available	Shortfall
Biology	£34.82	£28.45	£6.37	£43.83	£28.45	£15.38
Chemistry	£93.78	£28.45	£65.33	£93.78	£28.45	£65.33
Physics	£296.82	£28.45	£268.37	£436.91	£28.45	£408.46

For pupils taught in classes of 24, the annual cost of providing an effective science education, *excluding items such as textbooks, photocopying, servicing resources and subscriptions*, as derived above is a minimum of £20.58 per pupil aged 11 to 16 for "essential" resourcing and £29.14 per pupil aged 11 to 16 where "desirable" resourcing is included. Where the class size is 30 these costs rise to £22.22 per pupil per year for "essential" resources and £30.75 per pupil per year for "essential and desirable". This survey did not explore the actual size of science classes, although in a small survey[30] reported in 1998 (see section 1.2.1) class sizes in LEA schools were reported as 31.5 in Key Stage 3 and 23.1 in Key Stage 4.

The average sum of money currently available to school science departments for pupils age 11 to 16 from the survey on science funding allocations is £8.78 per pupil per year. In most schools this sum has to cover **all** costs (except staff and examination entry fees) associated with science and not just those identified in the resources lists.

It is therefore apparent that even where the lowest possible estimate of costs is used and all discounts are taken into account, the average sum currently allocated by schools falls dramatically short and is just over a third of what is needed. This raises questions about the ability of many departments to provide an effective science education. Present allocations even fall significantly short of the Royal Society estimates in 1997 which showed that the cost of science provision for pupils aged 11-16 for just the scientific essentials was £11.38 per pupil per year (also assessed without inclusion of items such as text books and photocopying).

For pupils taught in classes of 24. these figures therefore show a minimum shortfall of about **£11.80 (£20.58 - £8.78) per pupil per year** for 11 to 16 year olds to meet even the "essential" level of resources excluding textbooks and the other items identified above. The shortfall would rise to **£20.36 (£29.14 - £8.78) per pupil per year** if comparison is made with the "desirable" resources list. If pupils are taught in classes of 30, the shortfall rises to £13.44

[30] *Science teaching resources: 11 – 16 year olds. The Survey Findings*, P Ramsden, *Education in Science,* 180 (November 1998), pp 19 – 21.

(£22.22 - £8.78) for essentials only and £21.97 (£30.75 - £8.78) if desirables are included.

According to DfES[31] statistics there were 2 916 590 pupils within English secondary schools in the age range of compulsory education in 2002. This means that **each year** there is a national shortfall if pupils are taught in classes of 24 **in excess of £34 415 762 (£11.80 x 2 916 590)** even to cover essential resources. The annual shortfall rises to **£59 381 772 (£20.36 x 2 916 590)** if desirable items are included. If pupils are taught in classes of 30, the shortfalls rise to £39 198 670 (£13.44 x 2 916 590) and £64 077 482 (£21.97 x 2 916 590). If we assume that around half the classes are taught in groups of 30 (probably an under-estimate), in round figures it is reasonable to say that **science departments need at least a further £37 million per year to provide a reasonable level of resources** for teaching science to 11 to 16 year olds and possibly much more. This amounts to more than **£10 000 extra per science department per year.**

For 16 to 18 year old pupils, the annual cost of providing an effective science education, *still excluding items such as textbooks, photocopying, resources servicing and subscriptions*, can only be derived for each subject as shown above in section 3.3.8. It is clear that the actual cost of even just essential items is far greater than the average **£28.45** per pupil per science subject per year schools actually allocate at present and even where a full 10% discount is estimated for all items. The actual shortfall ranges from about £6 per pupil per year for biology to nearly £270 per pupil per year for physics. It is possible that this discrepancy in physics is one cause of the relative unpopularity of physics as a degree subject and of the well-known shortage of physics teachers.

The gap is even greater when desirable items are included especially when it is considered that the sum allocated by schools usually has to encompass all costs associated with science, ie books and reprographics, etc and not just those identified in the resources lists.

As for pupils aged 11 to 16, this leaves a massive shortfall in current funding in most schools even when only essential resources are taken into consideration. Bearing in mind that many pupils will take more than one science subject, the actual shortfall could range between £6 per pupil per year where a pupil is taking only biology to £340 per pupil per year where a pupil is studying all three sciences.

The DfES statistics quoted above also showed that there were 329 910 pupils within English secondary schools in the 16 to 18 age range. Even if only about half of these were studying science this would amount to about 160 000 pupils. This means that each year for post-16 work in schools there is a national shortfall **of between £960 000 (£6 x 160 000) to £54 400 000 (£340 x 160 000)** even to cover essential resources. The annual shortfall rises even

[31] *Statistics of Education 2003*, London: DfES, 2003.

further if desirable items are included. These figures need to be added to the shortfall already identified for 11-16 work.

Further research is needed to widen the scope of this review to all educational institutions which offer advanced post-16 courses in science and to establish in greater depth the degree of the financial shortfall.

3.4 Final Comments

We would be the first to admit that, especially for post-16 work, we have had to make a number of assumptions which could be challenged. Further research would be needed to check the validity of those assumptions, although they are based on professional experience in the field. However, it seems unquestionable that schools need much more money on an annual basis if they are to teach science effectively and encourage young people to continue with their study of science.

Rising costs as well as frequent and significant changes to patterns of external examination requirements and specifications have all led to pressure on science department finances. The survey reveals that only a minority of science departments receive enough money to ensure that provision of effective science teaching to both 11 to 16 year old and post-16 pupils is not inhibited by lack of resources. The wide variation in the funding available to science departments is very difficult to justify. A substantial majority fall below the estimated costs of even essential provision, some well below. It must be doubtful whether some schools are able to teach science effectively or even, in some cases, to meet the requirements of the National Curriculum and advanced science specifications. There is also a concern that funding for science departments has not risen in line with inflation over the past two years and probably not over the last six years or more.

Replacement of larger items of equipment and newer items required to bring school science into the 21st century is increasingly beyond the purchasing powers of most science departments. In some schools, even basic scientific equipment and consumables are difficult to fund. The appropriate use of ICT in science is inhibited in many schools by lack of access to computers, support equipment and other technological aids to teaching. The effective teaching of science is also inhibited by the state of many school science laboratories which is dealt with in section 2 of this report.

Pupils are likely to see science as an unattractive, under-funded option. We should not be surprised if they choose other subjects post-16, or in higher education or after graduating. Science teaching, especially, is unlikely to be seen as a high-status career.

In the words of some of the respondents to the questionnaire:

- *Our labs look like Steptoe's yard*
- *Even I am beginning to dislike science*
- *Staff morale is falling*
- *Can't keep staff for more than a year*

- *We continue to look like a 1950s science area.*

Appendices to section 2

Appendix 2.1 Criteria for laboratory quality

A Unsatisfactory / unsafe standard

A laboratory is unsatisfactory / unsafe if some or all of the following conditions apply. (In severe cases, one unsatisfactory/unsafe condition could be enough. *For example, a laboratory of 70 m^2 is too small for 30 pupils. A laboratory of 78 m^2 might be just acceptable, but if additional factors applied (eg, poor ventilation) then it becomes unsatisfactory.*)

- The laboratory is too small for a class of 30 (KS 3 & 4, or 20 at A-level)
- Lack of easy access to gas / electricity cut-offs.
- Poor ventilation and/or very high solar gain and/or high humidity.
- Poor heating.
- Lack of health and safety equipment – eyewash facility/ fire extinguisher / fire blanket.
- Benches / furniture / services with significant damage / graffiti.
- Insufficient sockets / gas taps / water taps / sinks in working order.
- Insufficient space for ancillary equipment (water baths, balances, etc).
- Floor with trip hazards – floor covering peeling up or with large holes in it / large cracks in concrete / tiles missing, loose or rising up.
- Poor acoustics.
- Poor visibility (teacher/pupils, pupils /chalkboard, etc).
- Poor facilities for display of posters & other stimulus material.

B Basic standard

This type of laboratory will have sufficient benches and stools for all pupils and sufficient sinks and water taps, mains electrical sockets, and gas taps for groups of two pupils to work on practical with the maximum class size in the room. Nevertheless it will not enable a good, modern teaching and learning atmosphere for the following reasons.

- One or two of the items applicable to an unsatisfactory laboratory apply in a minimum way, but overall the laboratory cannot be described as unsatisfactory.
- Levels of decoration are poor.
- Illumination levels are too low.
- Poor blackout / dimout facilities.
- The laboratory has to be used for significant amounts of storage (not just routine items such as Bunsens, glassware, etc).
- There is only one teaching position – with the bare minimum of one blackboard / whiteboard; limited demonstration facilities.
- No flexibility in the way tables/benches can be used.
- There are no ICT facilities permanently provided or easily/readily available (no OHP, no video player, no computer).

C Good standard

To be able to create a good teaching and learning atmosphere, this standard will include all the basic equipment, plus most/all of the following.

- One or two of the items applicable to a basic laboratory apply in a minimum way, but overall, the laboratory cannot be described as just basic.
- Good standard of decoration (kept maintained) and good levels of illumination.
- Two or more teaching areas, with whiteboard, projector screen.
- One up-to-date computer (and compatible data-logger, with range of sensors, available (perhaps shared with one or two other laboratories).
- Permanent OHP + screen; TV with video / DVD player.
- Data projector available (perhaps shared with one or two other laboratories).
- Easy movement around the room for teacher and/or pupils, with adequate storage for coats and bags.

D Excellent standard

This will include all the criteria of the 'Good' standard, plus the following.

- Data projector as standard – with screen and laptop computer or interactive whiteboard + lap top computer.
- Internet access.

Up to 15 computers available (perhaps shared with one or two other laboratories) networked and with compatible dataloggers.

Appendix 2.2 Questionnaire on laboratory provision

CLEAPSS School Science Service
on behalf of the Royal Society of Chemistry
SURVEY of LABORATORY PROVISION

1 Basic school data

Q1	Name of person filling in form		
Q2	Position held		
Q3	Name of School		
Q4	School postcode		
Q5	Name of LEA in which school situated		
Q6	Type of school *(please tick one box)*		
	• Comprehensive (all ability), including middle schools		
	• Specialist (all ability - *state specialism*)		
	• Specialist (restricted ability range – *state specialism & range)*		
	• Grammar (restricted ability range – higher)		
	• Secondary Modern (restricted ability range - lower)		
	• Other (*please specify*)		
Q7	Age range *(please tick one box)*		
	• 11 - 16		
	• 11 - 18		
	• 14 - 18		
	• Other (*please specify*)		
Q8	Status of school *(please tick one box)*		
	• Community school (ie, 'ordinary' LEA school)		
	• Voluntary controlled school		
	• Voluntary aided school		
	• Foundation school		
	• Other *(please specify)*		

2 Number of teaching laboratories

Q9	Irrespective of their condition / quality, how many laboratories do you have?	
Q10	Based on the situation in your school this term, if all science teaching were to take place in laboratories, AND no class in key stages 3 and 4 exceeded 30 pupils, AND no sixth form group exceeded 20 pupils, how many ***extra*** laboratories would you need *(round upwards to a whole number)*?	

3 Quality / condition of teaching laboratories

Q11	Please read carefully the *Criteria for Laboratory Quality* **(opposite)** and state how many of the laboratories referred to in Q9 come into each category	
	A Number classed as unsatisfactory / unsafe standard	
	B Number classed as basic standard	
	C Number classed as good standard	
	D Number classed as excellent standard	
Q12	Are there working fume cupboards available for at least half the laboratories used for teaching chemistry in key stages 3 and 4 (whether taught as a separate subject or as a part of science)?	Yes / no
Q13	If NO, how many ***extra*** fume cupboards would be needed?	
Q14	Does each laboratory used for teaching A/S or A2 chemistry have at least 2 working fume cupboards available?	Yes / no / not applicable
Q15	If NO, how many ***extra*** fume cupboards would be needed?	

Q16 Please add here any comments you wish to make about the quantity or quality of laboratory provision, especially any comments about how it affects the quality of the curriculum.

4 Preparation and storage areas

We have not listed the criteria for judging preparation and storage areas because so much is dependent on local circumstances. However, some of the criteria given for laboratories will be equally appropriate.

Q17	Please classify the total ***amount of space*** available for storage of chemicals and equipment, not in teaching labs (*tick one box)*	
	• Poor	
	• Basic - barely adequate	
	• Good	
	• Excellent	
Q18	Please classify the total ***amount of space*** available for preparation of lessons by technicians (*tick one box)*	
	• Poor	
	• Basic - barely adequate	
	• Good	
	• Excellent	
Q19	Please classify the ***quality / condition*** of the prep rooms and storage areas (*tick one box)*	
	• Poor	
	• Basic	
	• Good	
	• Excellent	
Q20	Please classify the ***proximity / accessibility*** of the prep rooms and storage areas to the teaching labs (*tick one box)*	
	• Poor	
	• Basic	
	• Good	
	• Excellent	
Q21	Does at least one of the prep rooms have a working fume cupboard available?	Yes / no
Q22	Does the department have at least one dishwasher?	Yes / no
Q23	If any of the laboratories are not on the ground floor, is there a lift or hoist that can be used to transport equipment between floors?	Yes / no / not applicable

Q24 Please add here any comments you wish to make about the quantity or quality of prep room / storage provision, especially any comments about how it affects the quality of the curriculum.

Appendix 2.3 Questionnaire response rate by types of respondent

Nº Sent out	Returned		Returned by	Nº returned	%
	Nº	% of sent out			
1759	**744**	**42.3%**	Teachers	386	51.9
			Technicians	328	44.1
			Other	30	4.0
			Totals	744	100%

Type of LEA	Nº sent out	% of sent out	Nº returned	% of returned
High spending	382	21.7	135	18.2
Medium spending	597	33.9	245	32.9
Low spending	780	44.4	364	48.9
Totals	1759	100%	744	100%

Type of school	Nº returned	% of returned
Comprehensive	474	63.7
Grammar	31	4.2
Secondary Modern	32	4.3
Specialist science	112	15.1
Specialist, non-science	84	11.3
Specialist, restricted	10	1.3
Other	1	0.1
Totals	744	100%

Age groups in school	Nº returned	% of returned
11-16	279	37.5
11-18	357	48.0
14-18	32	4.3
Other -- Middle	54	7.2
Other -- Secondary	22	3.0
Totals	744	100%

Status of school	Nº returned	% of returned
Community	532	71.5
Foundation	84	11.3
Voluntary controlled	17	2.3
Voluntary aided	110	14.8
Other – City Academy	1	0.1
Totals	744	100%

Appendix 2.4 Quality of laboratories by type of respondent

	Laboratories		Unsatis/Unsafe		Basic		Good		Excellent	
	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%
Overall data*										
	5569	100	1386	24.9	2262	40.6	1641	29.5	280	5.0
Type of LEA										
High spend	1033	100	274	26.5	417	40.4	288	27.9	54	5.2
Medium spend	1877	100	474	25.3	772	41.1	584	31.1	47	2.5
Low spend	2659	100	638	24.0	1073	40.4	769	28.9	179	6.7
Type of school										
Comprehensive	3363	100	841	25.0	1382	41.1	977	29.1	163	4.8
Grammar	255	100	63	24.7	103	40.4	76	29.8	13	5.1
Secondary Mod	185	100	49	26.5	89	48.1	44	23.8	3	1.6
Spec. science	965	100	231	23.9	362	37.5	306	31.7	66	6.8
Spec.non-science	740	100	192	25.9	302	40.8	213	28.8	33	4.5
Spec. restricted	56	100	10	17.9	24	42.9	20	35.7	2	3.6
Other*										
Age groups										
11-16	1805	100	480	26.5	681	37.7	528	29.3	116	6.4
11-18	3157	100	745	23.6	1342	42.5	945	29.9	125	4.0
14-18	286	100	83	29.0	106	37.1	74	25.9	23	8.0
Other - Middle	124	100	29	23.4	46	37.1	42	33.9	7	5.6
Other- Secondary	197	100	49	24.9	87	44.2	52	26.4	9	4.6
Status of school										
Community	3980	100	1024	25.7	1542	38.7	1208	30.3	206	5.2
Foundation	687	100	170	24.7	296	43.1	187	27.2	34	4.9
Volunt. controlled	137	100	37	27.0	42	30.7	54	39.4	4	2.9
Voluntary aided	753	100	155	20.6	382	50.7	192	25.5	24	3.2
Other- City Acad.*										

* Responses from some types of school were so insignificant that they have been excluded from all except the Overall data figures, hence totals may not exactly tally.

Appendix 2.5 Number of laboratories by type of respondent

	Schools in sample	Labs overall	Additional labs required		Labs per school	Additional labs per school
	Nº *a*	Nº *b*	Nº *c*	% *c/b*	Nº *b/a*	Nº *c/a*
Overall data*						
	744	5569	785	14.1	**7.5**	**1.1**
Type of LEA						
High spend	135	1033	139	13.5	7.7	1.0
Medium spend	245	1877	263	14.0	7.7	1.1
Low spend	364	2659	383	14.4	7.3	1.1
Type of school						
Comprehensive	474	3363	474	14.1	7.1	1.0
Grammar	31	255	44	17.3	8.2	1.4
Secondary Modern	32	185	28	15.1	5.8	0.9
Spec. science	112	965	134	13.9	8.6	1.2
Spec. non-science	84	740	96	13.0	8.8	1.1
Spec. restricted	10	56	9	16.1	5.6	0.9
Age groups						
11-16	279	1805	222	12.3	6.5	0.8
11-18	357	3157	451	14.3	8.8	1.3
14-18	32	286	38	13.3	8.9	1.2
Other - Middle	54	124	41	33.1	2.3	0.8
Other - Secondary	22	197	33	16.8	9.0	1.5
Status of school						
Community	532	3980	519	13.0	7.5	1.0
Foundation	84	687	118	17.2	8.2	1.4
Voluntary controlled	17	137	24	17.5	8.1	1.4
Voluntary aided	110	753	124	16.5	6.8	1.1

* Responses for other establishments were so insignificant that they have been excluded from all except the Overall data figures, hence totals may not exactly tally.

Appendix 2.6 Fume cupboards in laboratories by type of respondent

	Key Stages 3 / 4						A/S and A/2						
	Sufficient		Not sufficient		Nº req.	Nº req. / sch	Not appli-cable	Sufficient		Not sufficient		Nº req.	Nº req. / sch
	Nº	%	Nº *a*	%	*b*	*b/a*	Nº	Nº	%	Nº *c*	%	*d*	*d/c*
Overall data*													
Nº schools = **744**	276	37	**468**	63	1037	**2.2**	355	72	19	**314**	81	704	**2.2**
Type of LEA													
High spend	46	34	89	65	218	2.4	70	16	25	48	75	105	2.2
Medium spend	100	41	145	59	336	2.3	102	23	16	120	84	277	2.3
Low spend	130	35	234	64	483	2.1	183	33	18	146	82	324	2.2
Type of school													
Comp.	168	35	306	65	661	2.2	256	43	20	174	80	382	2.2
Grammar	21	67	10	32	23	2.3	0	7	23	24	77	52	2.2
Secondary Modern	12	38	20	63	48	2.4	22	0	0	10	100	16	1.6
Spec. science	43	38	69	62	174	2.5	40	9	13	62	87	157	2.5
Spec. non-sci	28	33	56	67	120	2.1	31	11	21	41	79	91	2.2
Spec. restrict.	3	30	7	70	11	1.6	6	2	50	2	50	4	2.0
Age groups													
11-16	97	35	182	65	371	2.0	279	0	0	0	0	0	0
11-18	138	39	219	61	546	2.5	18	62	18	275	82	607	2.2
14-18	17	53	15	46	44	2.9	0	7	22	25	78	57	2.3
Other-Middle	13	24	41	76	50	1.2	53	0	0	0	0	0	0
Other- Secon.	11	50	11	50	26	2.4	5	3	18	14	82	34	2.4
Status of school													
Community	184	35	348	65	761	2.2	284	50	20	195	80	439	2.3
Foundation	40	48	44	52	110	2.5	21	9	14	54	86	129	2.4
Vol. control.	6	35	11	65	24	2.2	5	2	17	10	83	19	1.9
Vol. aided	45	41	65	59	142	2.2	45	11	17	54	83	115	2.1

* Responses for other establishments were so insignificant that they have been excluded from all except the Overall data figures, hence totals may not exactly tally.

Appendix 2.7 Quality of prep rooms by type of respondent

	Nº replies		Poor		Basic		Good		Excellent	
	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%
Overall data*										
	706	100	150	21	304	43	223	32	29	4.1
Type of LEA										
High spend	130	100	38	29	49	38	35	27	8	6.2
Medium spend	235	100	50	21	107	46	69	29	9	3.8
Low spend	341	100	62	18	148	43	119	35	12	3.5
Type of school										
Comprehensive	451	100	97	22	200	44	135	30	19	4.2
Grammar	29	100	4	14	12	41	11	38	2	6.9
Secondary mod.	32	100	8	25	14	44	10	31	0	0.0
Spec. science	102	100	20	20	43	42	37	36	2	2.0
Spec. non-sci.	81	100	21	26	30	37	26	32	4	4.9
Spec. restricted	10	100	0	0	5	50	3	30	2	20
Age groups										
11-16	270	100	64	24	112	42	77	29	17	6.3
11-18	339	100	68	20	143	42	117	35	11	3.2
14-18	28	100	4	14	15	54	8	39	1	3.6
Other - Middle	49	100	11	22	25	51	13	27	0	0.0
Other – Second.	20	100	3	15	9	45	8	40	0	0.0
Status of school										
Community	504	100	104	21	218	43	158	31	24	4.8
Foundation	79	100	13	17	34	43	31	39	1	1.3
Vol. controlled	17	100	0	0	3	18	9	53	5	29
Voluntary aided	105	100	30	29	43	41	29	28	3	2.9

* Responses for other establishments were so insignificant that they have been excluded from all except the Overall data figures, hence totals may not exactly tally.

Appendix 2.8 Storage space in / for prep rooms by type of respondent

	Nº responses		Poor		Basic		Good		Excellent	
	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%
Overall data*										
	706	100	128	18	315	45	226	32	37	5.2
Type of LEA										
High spend	130	100	24	19	52	40	47	36	7	5.4
Medium spend	234	100	44	19	107	46	69	30	14	6.0
Low spend	342	100	60	18	156	46	110	32	16	4.7
Type of school										
Comprehensive	451	100	81	18	204	45	139	31	27	6.0
Grammar	29	100	9	31	11	38	8	28	1	3.4
Secondary modern	32	100	6	19	13	41	12	38	1	3.1
Spec. science	102	100	17	17	46	46	36	35	3	2.9
Spec. non-science	81	100	14	17	34	42	29	36	4	4.9
Spec. restricted	10	100	1	10	7	70	1	10	1	10
Age groups										
11-16	270	100	52	19	113	42	88	33	17	6.3
11-18	340	100	58	17	156	46	108	32	18	5.3
14-18	27	100	4	15	15	56	8	30	0	0.0
Other - Middle	49	100	11	22	22	45	15	31	1	2.0
Other - Secondary	20	100	3	15	9	45	7	35	1	5.0
Status of school										
Community	505	100	83	16	228	45	164	32	30	5.9
Foundation	78	100	20	26	30	39	25	32	3	3.8
Voluntary controlled	17	100	1	6	10	59	6	35	0	0.0
Voluntary. aided	105	100	24	23	47	45	30	29	4	3.8

* Responses for other establishments were so insignificant that they have been excluded from all except the Overall data figures, hence totals may not exactly tally.

Appendix 2.9 Size of prep rooms by type of respondent

	Nº responses		Poor		Basic		Good		Excellent	
	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%
Overall data*										
	706	100	169	24	296	42	209	30	32	4.5
Type of LEA										
High spend	130	100	25	19	54	44	41	32	10	7.7
Medium spend	234	100	60	26	97	42	69	30	8	3.4
Low spend	342	100	84	25	145	42	99	29	14	4.1
Type of school										
Comprehensive	451	100	112	25	184	41	133	30	22	4.9
Grammar	29	100	4	14	20	69	3	10	2	6.9
Secondary modern	32	100	8	25	12	38	12	38	0	0.0
Spec. science	102	100	22	22	44	43	33	43	3	2.9
Spec. non-science	81	100	21	26	32	40	24	30	4	4.9
Spec. restricted	10	100	2	20	4	40	3	30	1	10
Age groups										
11-16	270	100	67	25	102	38	83	31	18	6.7
11-18	340	100	72	21	151	44	104	31	13	3.8
14-18	27	100	7	26	14	52	5	19	1	3.7
Other - Middle	49	100	16	33	21	43	12	25	0	0.0
Other - Secondary	20	100	7	35	8	40	5	25	0	0.0
Status of school										
Community	505	100	122	24	207	41	155	31	21	4.2
Foundation	78	100	17	22	32	41	27	35	2	2.6
Voluntary controlled	17	100	5	30	9	53	3	18	0	0.0
Voluntary aided	105	100	25	24	48	46	24	23	8	7.6

- Responses for other establishments were so insignificant that they have been excluded from all except the Overall data figures, hence totals may not exactly tally.

Appendix 2.10 Accessibility of prep rooms by type of respondent

	Nº responses		Poor		Basic		Good		Excellent	
	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%
Overall data*										
	705	100	82	12	168	24	370	53	85	12.1
Type of LEA										
High spend	129	100	17	13	31	24	62	48	19	15
Medium spend	234	100	23	10	65	28	122	52	24	10
Low spend	342	100	42	12	72	21	186	54	42	12
Type of school										
Comprehensive	451	100	47	10	108	24	238	53	58	13
Grammar	29	100	3	10	8	28	14	48	4	14
Secondary modern	32	100	4	13	9	28	17	53	2	6
Spec. science	102	100	15	15	22	22	54	53	11	11
Spec. non-science	80	100	11	14	18	23	43	54	8	10
Spec. restricted	10	100	2	20	3	30	3	30	2	20
Age groups										
11-16	269	100	36	13	56	21	142	53	35	13
11-18	340	100	38	11	87	26	177	53	38	11
14-18	27	100	4	15	9	33	13	48	1	4
Other - Middle	49	100	1	2	9	18	29	59	10	20
Other - Secondary	20	100	3	15	7	35	9	45	1	5
Status of school										
Community	504	100	53	11	113	22	277	55	61	12
Foundation	78	100	13	17	19	24	36	46	10	13
Voluntary controlled	17	100	1	6	7	41	9	53	0	0
Voluntary aided	105	100	15	14	29	28	48	46	13	12

* Responses for other establishments were so insignificant that they have been excluded from all except the Overall data figures, hence totals may not exactly tally.

Appendix 2.11 Fume cupboards in prep rooms by type of respondent

	Nº responses		Fume cupboard available		No fume cupboard available	
	Nº	%	Nº	%	Nº	%
Overall data*						
	744	100	377	51	367	49
Type of LEA						
High spend	135	100	74	55	61	45
Medium spend	245	100	128	52	117	48
Low spend	364	100	175	48	189	52
Type of school						
Comprehensive	474	100	235	50	239	50
Grammar	31	100	18	58	13	42
Secondary Modern	32	100	10	31	22	69
Spec. science	115	100	58	50	57	50
Spec. non-science	84	100	50	60	34	40
Spec. restricted	7	100	5	71	2	29
Age groups						
11-16	279	100	142	51	137	49
11-18	357	100	196	55	161	45
14-18	32	100	18	56	14	44
Other - Middle	54	100	6	11	48	89
Other - Secondary	22	100	15	68	7	32
Status of school						
Community	532	100	260	49	272	51
Foundation	84	100	51	61	33	39
Voluntary controlled	17	100	10	59	7	41
Voluntary. aided	110	100	55	50	55	50

- Responses for other establishments were so insignificant that they have been excluded from all except the Overall data figures, hence totals may not exactly tally.

Appendix 2.12 Availability of dishwashers and lifts by type of respondent

	Dishwasher					Lift					
	Nº resp-onses	Available		Not available		Not appl-icable	Nº appl-icable	Available		Not available	
	Nº	Nº	%	Nº	%	Nº	Nº	Nº	%	Nº	%
Overall data*											
	744	472	63	272	37	276	427	151	35	276	65
Type of LEA											
High Spend	135	77	57	58	43	35	95	32	34	63	66
Medium spend	245	174	71	71	29	84	147	51	35	96	65
Low spend	364	221	59	143	39	159	185	68	38	117	62
Type of school											
Comprehensive	474	285	60	189	40	196	252	81	32	171	68
Grammar	31	25	81	6	19	3	26	11	42	15	58
Secondary Modern	32	18	56	14	44	12	19	7	37	12	63
Spec. science	112	75	67	37	33	36	66	27	41	39	59
Spec. non-science	84	63	75	21	25	24	58	22	38	36	62
Spec. restricted	10	5	50	5	50	5	5	3	60	2	40
Age groups											
11-16	279	166	60	113	40	108	160	58	36	102	64
11-18	357	255	71	102	29	112	226	79	35	147	65
14-18	32	25	78	7	22	8	20	10	50	10	50
Other - Middle	54	12	22	42	78	40	9	3	33	6	67
Other - Secondary	22	14	64	8	36	8	12	1	8	11	92
Status of school											
Community	532	323	61	209	39	215	287	103	36	184	64
Foundation	84	62	74	22	26	28	50	17	34	33	66
Voluntary controlled	17	13	76	4	24	7	10	2	20	8	80
Voluntary aided	110	73	66	37	34	26	79	28	35	51	65

* Responses for other establishments were so insignificant that they have been excluded from all except the Overall data figures, hence totals may not exactly tally.

Appendix 2.13 Evaluations by science advisers and consultants

	Laboratories	Unsatis/Unsafe	Basic	Good	Excellent
	Nº	%	%	%	%
LEA 1	**Urban; high spending**				
	106	33	37	16	13
LEA 2	**Mixed, mainly rural; low spending**				
	448	41	21	33	5
	Responses to questionnaires from 19 schools				
	127	28	32	34	6
LEA 3	**Urban; medium spending**				
	Estimated %	12	70	15	3
LEA 4	**Mixed, mainly suburban; medium spending**				
	73	22	55	22	1
LEA 5	**Mixed, mainly suburban; medium spending**				
	Estimated %	3	47	47	3

Evaluations on school responses by a science education consultant, on schools known to consultant

		Unsatis/ Unsafe		Basic		Good		Excellent	
		Nº		Nº		Nº		Nº	
School	LEA spending	School	*Consult*	School	*Consult*	School	*Consult*	School	*Consult*
A	Medium	4	*4*	0	*0*	0	*0*	0	*0*
B	Medium	0	*0*	6	*6*	1	*1*	0	*0*
C	Medium	2	*2*	5	*5*	2	*2*	0	*0*
D	High	6	*3*	4	*7*	0	*0*	0	*0*
E	High	8	*4*	0	*4*	0	*0*	0	*0*
F	High	1	*1*	2	*2*	2	*2*	0	*0*
G	High	0	*0*	0	*0*	4	*4*	0	*0*
H	High	2	*2*	0	*0*	2	*2*	0	*0*

Appendix 2.14 Costs of improvements and basis for estimates

Appendix 2.14.1 Laboratories

Costs were estimated in several different ways.

New build cost:

(a) From DfES figures in *Science Accommodation in Secondary Schools Building Bulletin 80* (revised 1999), DfES (then DfEE) (from page 47)

Constructing and fitting out a new science building, excluding land costs and VAT, is given as £1000 - £1400 per m² of gross floor area. Costs are for 1999.

With the rise in RPI, this translates in today's terms to £1100 - £1500 per m².

(The rise in the Retail Price Index from June 1999 (165.6) to June 2003 (181.3) is 9.5%.)

For one laboratory of 90 m² (ignoring essential corridors and prep rooms),

New build of 1 laboratory = £99 000 – £135 000

Allowing 10 m² of corridor space, and 15 m² for a share of prep room space *(see Example A, page 28)*, leads to a gross space for one laboratory of 115 m²

New build (gross) = £126 000 -- £172 500

To build a new laboratory therefore costs conservatively on average, £145 000

Refurbishment costs

(a) From DfES figures in *Science Accommodation in Secondary Schools Building Bulletin 80* (revised 1999), DfES (then DfEE) (from page 51)

Adaptation Case Study 1, average of three options given is £366.20 per m².

Adaptation Case Study 3, cost given is £561.50 per m².

Taking account of the rise in the Retail Price Index of 9.5%, current costs are:

Case Study 1 = £401.00 per m²

Case Study 3 = £614.80 per m².

For one laboratory at 90m² this gives costs of **Case Study 1 = £36 100**

Case Study 2 = £55 300

(b) Laboratory Design and Manufacturing firms

Four firms were approached for current costs of refurbishing laboratories:

Design and Manufacturing firm A

This firm also project manages refurbishments if asked.

Refurbish one laboratory, approximate prices:

'Basic' standard

Furniture – supplied and fitted	£12 000 – 15 000
Resurface floor	£4000
Install / alter services	£3000 - 6000
Ceiling	£2000 - 3000
Decoration	£1500
Gas controls	£1200 - 2000
Fume cupboard	£1800
-- ducting	£2000

This gives a range of prices for one laboratory at a **basic level** of **£25 500 -- £35 300.**

This does not include blinds or ICT – or any structural work, new windows, roof repairs, etc.

From a recent, actual installation, this firm quoted a price for a high-quality lab of **£65 000**. The high quality came from a higher specification of steel tubing for the structure of the benches, *Corian* for the bench surfaces, plus construction of a presentation area with wiring ready laid for installation of ICT. This project was managed by the firm itself and should be compared to the LEA's overall quote, including project management and the services of an architect, of £110 000.

Design and Manufacturing firm B

This firm also project manages refurbishments if asked.

Refurbish one laboratory, approximate prices:

'Basic' standard

Furniture – supplied and fitted	£15 000 – 17 000
Strip out	£3000 – 5000
Resurface floor	£4500 - 5500
Install / alter services	£3000
Ceiling / lighting	£5005 - 6000
Decoration	£1000
Fume cupboard	£2500
-- ducting	£1500 - 3500

This gives a range of prices for one laboratory at a '**basic' level** of

£34 000 – £43 500.

This does not include blinds or ICT – or any structural work, new windows, roof repairs, etc.

Manufacturing firm C

This firm supplies and fits its own furniture only.

Furniture supplied and fitted for one laboratory:

'**Basic' standard**	**£12 000 – 15 000**
with **higher standard** work surfaces	**£18 000 – 20 000**

Base units, of any standard, said to have a life span of 10 –15 years.

Manufacturing firm D

This firm supplies and fits its own furniture only:

Furniture supplied and fitted for one laboratory:

'**Basic' standard**	**£11 000 – 15 000**

(c) Other sources of cost information

LEA science adviser

A recent laboratory refurbishment, LEA managed, at **£45 000**

Head of science department

Two recent laboratory refurbishments, each at **£50 000**

(d) Costs of additional items

Blinds, roller	**approximately**	**£1500**
Blinds, blackout	**approximately**	**£5500**
Interactive whiteboard (with projector) + installation	**approximately**	**£4000**
Replacement windows	**approximately**	**£15 000 – 20 000**
Move a door to a new position	**approximately**	**£1500**

Overall cost of refurbishment

Taking all of these figures into account, we assume that:

to refurbish a 90 m² laboratory, from Unsafe / Unsatisfactory to a Good standard costs **£55 000**

(This assumes a basic cost of about £45 000, with some ICT and blinds added at about £10 000, but does not include any major structural work, new windows, roof repairs, etc.)

To refurbish a 90 m² laboratory from Basic to a Good standard:

The Basic criteria cover a wide range. At the top end, the furniture will not need replacing and the cost might include (see prices above, using conservative examples):

Decoration	£1000
Floor	£4000
Ceiling + lights	£6000
Total	£11 000

At the bottom end, the costs are likely to be as for Unsafe/Unsatisfactory to Good standard, otherwise £55 000.

An average of the two would be £33 000.

Therefore, conservatively, a laboratory **refurbishment from Basic to Good standard is estimated as** **£30 000**

Appendix 2.14.2 Preparation rooms

Extending Prep Rooms

From Appendix 2.8, 18% of prep rooms have poor storage space. From Appendix 2.9, 24% of prep rooms have poor preparation space. On top of these two percentages, many of the written responses point to inadequate space for teachers to prepare.

Finding more prep room space would probably mean reallocating this from other rooms in a school. The end result would be that a school requires more buildings. In order to cost this, an increase in the floor area of a prep room has been estimated at one fifth of the total (**22 m²**), about the size of a large reception room in a private house. Given that an average department might have 8 teachers and three technicians, this would give an extra amount of space of 2 m² for each person.

From DfES figures in *Science Accommodation in Secondary Schools Building Bulletin 80* (revised 1999), DfES (then DfEE)

New build costs at average, *from page 47 and above*, £1300 per m^2

Average prep room size, for 7 labs, taken from Example A, *page 28,* is 110 m^2

To extend the prep room area by 20%, therefore means about 22 m^2

22m^2 at a cost of £1300 per m^2 is, conservatively, **£28 000.**

Refurbishing existing Prep Rooms

From DfES figures in *Science Accommodation in Secondary Schools Building Bulletin 80* (revised 1999), DfES (then DfEE)

Refurbishment costs:

taken from the average of Case Study 1 costs, *page 51 and above*, are £401.00 per m^2

taken from Case Study 3, page 51 and above, are £614.80 per m^2

Therefore to refurbish a 110 m^2 prep room to a good standard:

110 m^2 at a cost of £401.00 per m^2 is £44 100

110 m^2 at a cost of £614.80 per m^2 is £67 600

Working from the costs of laboratory refurbishments above:

From Unsafe/Unsatisfactory to Good = £55 000 for a 90 m^2 laboratory

From this remove £5000 for whiteboard, leading to £50 000.

From Basic to Good = £30 000 for a 90 m^2 laboratory

From this remove £5 000 for whiteboard, leading to £25 000.

To refurbish a 110 m^2 Prep Room from a Poor to Good standard:

50 000 x 110 / 90 = 61.1 conservatively, **£60 000**

To refurbish a 110 m^2 Prep Room from a Basic to Good standard:

25 000 x 110 / 90 = 30.5 conservatively, **£30 000**

Prep Room items

Fume cupboard approximate £2200

- ducting approximate £2200

overall £4400

(prices from Design and Manufacture firms and from GLS Supplies)

Dishwasher

Lowest priced, laboratory dishwasher from Fisher Scientific:

Lancer 810X, basic cost £4363, plus essential accessories at around £600

It is assumed that all the necessary services are plumbed in; high load mains electricity, hot and cold water and drainage.

overall £4500

Appendix 2.14.3 Lift between floors

Discussion with OTIS (specialists in lift installation) reveals that the cheapest option is probably a standard eight-person lift. This provides facilities for people in wheelchairs. It also enables materials and equipment to be moved by trolley between floors and is cheaper than a specially-made hoist installed within prep rooms.

Eight-person lift, between two floors only:

supplied and fitted at an approximate cost of **£20 000**

(not including any extra building works that may be necessary.)

Obviously some science departments may have more than two floors, which would lead to even higher costs and, if a passenger lift is a long way from the prep room a hoist may need to be considered in addition.

Appendix 2.15 Overall costs for improving provision in maintained secondary schools in England

[Note that throughout this section, figures have been rounded to the nearest million pounds.]

Number of schools and laboratories

Questionnaires posted to 1759 schools, this being half of all maintained schools in England.

Therefore, number of schools in total = 3518

- Number of returned questionnaires = 744

Therefore ratio of sample to whole is 3518 / 744 = 4.73

- Number of laboratories

Sample schools report 5569 laboratories.

Therefore number of laboratories in total is 5569 x 4.73 = 26 341

- Number of laboratories per school

Average is 26 341 / 3518 = 7.5

Costs of upgrading laboratories

From Unsafe/Unsatisfactory to a Good standard

26 341 x 24.9% = 6559 labs

Cost of each lab = £55 000

Total cost of all labs 6559 x £55 000 = **£361 000 000**

From Basic to a Good standard

26 341 x 40.6% = 10 694 labs

Cost of each lab = £30 000

Total cost of all labs 10 694 x £30 000 = **£321 000 000**

From Good to an Excellent standard

26 341 x 29.5% = 7771 labs

Cost of interactive whiteboard is £4000

Cost of 15 lap top computers is 15 x £970 (GLS Supplies) = £14 550

Total cost of all labs 7771 x £18 550 = **£144 000 000**

Cost of providing new laboratories

One laboratory per school = 3518 labs

Cost of new build for one laboratory is £145 000

Total cost of all labs 3518 x £145 000 = **£510 000 000**

Cost of upgrading prep rooms

Assuming one prep room per school (as per Example A, page 28 , *Building Bulletin 80*[32]) at 110 m^2

From Poor to a Good standard

3518 x 21% = 739 prep rooms

Cost of each prep room = £60 000

Total cost of all prep rooms 739 x £60 000 = **£44 000 000**

From Basic to a Good standard

3518 x 43% = 1513 prep rooms

Cost of each prep room = £30 000

Total cost of all prep rooms 1513 x £30 000 = **£45 000 000**

Cost of providing more storage and preparation space in prep rooms

The sample puts poor storage space in 18% of schools and poor preparation space in 24% of schools.

Assuming some overlap and with 24% of schools, as a conservative figure,

this gives 3518 x 24% = 844 prep rooms.

Cost of extending a prep room by 20% = £28 000

Total cost of all prep rooms 844 x £28 000 = **£24 000 000**

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32 *Science Accommodation in Secondary Schools, Building Bulletin 80,* DfEE, London: The Stationery Office, 1999.

Cost of providing sufficient fume cupboards

(assuming no other upgrading is taking place)

In laboratories at KS3/4

Number of schools needing more fume cupboards is

3518 x 0.63 = 2216

Number needed per school = 2

Cost per fume cupboard (ducted) = £4400

Total cost for all schools 2216 x 2 x £4400 = **£20 000 000**

In laboratories for A/S and A2

Not all schools have post-16 work.

Sample gives 314 schools from (355 + 72 + 314) = 42%

Number of schools needing more fume cupboards for post-16 is

3518 x 0.42 = 1478

Number needed per school = 2

Cost per fume cupboard (ducted) = £4400

Total cost for all schools 1478 x 2 x £4400 = **£13 000 000**

In prep rooms

Number of schools needing more fume cupboards is

3518 x 0.49 = 1724

Number needed per school = 1

Cost per fume cupboard (ducted) = £4400

Total cost for all schools 1724 x 1 x £4400 = **£8 000 000**

Cost of ensuring each science department has a dishwasher

(assuming that this is not part of an overall refurbishment)

Number of schools needing a dishwasher in science is

3518 x 0.37 = 1302

Cost per dishwasher = £4500

Total cost for all schools 1302 x £4500 = **£6 000 000**

Cost of providing a lift to all science departments that need one

Sample gives 427/703 = 61% of science departments operate on more than one floor.

Of these, 276/427 = 65% do not have a lift

Number of schools needing a lift is 3518 x 0.61 x 0.65 = 1395

Cost for a lift (between two floors only) = £20 000

Total cost for all schools 1395 x £20 000 = £**28 000 000**

Appendices to section 3

Appendix 3.1 Questionnaire on equipment provision

CLEAPSS School Science Service

on behalf of the **Royal Society of Chemistry**

SURVEY of EQUIPMENT PROVISION

1 Basic school data

Q1	Name of person filling in form	
Q2	Position held	
Q3	Name of School	
Q4	School postcode	
Q5	Name of LEA in which school situated	
Q6	Type of school *(please tick one box)*	
	• Comprehensive (all ability)	
	• Specialist (all ability – *state specialism*)	
	• Specialist (restricted ability range – *state specialism & range)*	
	• Grammar (restricted ability range – higher)	
	• Secondary Modern (restricted ability range - lower)	
	• Other (*please specify*)	
Q7	Age range *(please tick one box)*	
	• 11 - 16	
	• 11 - 18	
	• 14 - 18	
	• Other (*please specify*)	
Q8	Status of school *(please tick one box)*	
	• Community school (ie, 'ordinary' LEA school)	
	• Voluntary controlled school	
	• Voluntary aided school	
	• Foundation school	
	• Other *(please specify)*	
Q9	Numbers of pupils *(please write number in each box writing zero where appropriate)*	
	• Pupils 11-16	
	• Pupils 16-18	

2 Science department capitation

Where relevant, please give your answer to the nearest pound.

Q10	Total capitation for science in **current** financial year (to cover equipment, consumables, software, videos, textbooks, photocopying, printing, if you are charged for these. See Q16).	£
Q11	Does this include sums of money this year which do not recur typically each year? *(Please delete as appropriate).*	Yes / No
Q12	Total capitation for science in **last** financial year to cover equipment, consumables, software, videos, texts, copying.	£
Q13	Did this include sums of money last year which do not recur typically each year? *(Please delete as appropriate).*	Yes / No
Q14	If you answered Yes to either or both Q11 or Q13 please indicate the sum which would more typically be granted .	£
Q15	If you answered Yes to either or both Q11 or Q13 please identify the main sources of additional funds (eg, PTA, specialist school grant).	
Q16	Does the sum given in Q10 and Q12 include funding for the following items *(please delete as appropriate):*	
	• Textbooks	Yes/no
	• Printing / photocopying	Yes/no
	• ICT software	Yes/no
	• ICT hardware	Yes/no
	• Capital science equipment replacement programme (eg, low voltage units, balances, microscopes).	Yes/no
	• Laboratory support equipment replacement programme (eg, fridges, ovens, dishwashers)	Yes/no
	• Recurring annual maintenance costs (eg, fume cupboard checking and maintenance, pressure vessel checks)	Yes/no
	• Costs of service subscriptions (eg, to CLEAPSS, RPA services)	Yes/no
	• Costs of subscriptions to professional bodies (eg, to IoB, IoP, RSC, ASE)	Yes/no
	• Health and safety equipment (eg, safety screens, goggles)	Yes/no

3 Method of allocation of annual finances

Q17	Capitation is typically allocated *(please delete as appropriate):*	
	• Entirely by school-created formula	Yes/no
	• Entirely by annual departmental bid	Yes/no
	• Combination of formula and bid	Yes/no
	• Other method (*please specify briefly):*	Yes/no

Q18	If your school has pupils aged 16 – 18, has the change in the source of funding of these pupils to the LSC significantly altered the science department allocation?	Yes/no / not applicable
Q19	If you have answered Yes to Q18, please explain briefly how it has been affected.	

Q20 Please add here any comments you wish to make about **allocation** of capitation and other funding:

4 ICT equipment

Q21	How many laboratories do you have?	
Q22	How many laboratories are networked?	
Q23	How many desktop computers for pupil use in science?	
Q24	How many desktop computers in prep rooms/staff areas?	
Q25	How many lap top/palm top computers for pupil use in science?	
Q26	How many lap top/palm top computers in prep rooms/staff areas?	
Q27	Briefly indicate how your computers are serviced / maintained • Desktops • Laptops/palmtops	

Q28 Please add here any other comments about ICT equipment, its use and maintenance.

5 Sufficiency of funding

Q29	Do you feel that you are currently able to provide the very best quality learning in science? *(Please delete as appropriate)*	Yes / No
*If **Yes** please go straight to **Q31***	*If **No** please go to **Q30 and then Q31***	

		Tick	Rank
Q30	If you are currently **not** happy with the quality of learning you are able to provide in science, which are the main inhibiting factors *(please tick any which are relevant and put all ticked items in order of importance with 1 being the most important)*	***Tick***	***Rank***
	• Budget allocation to meet cost of resources		
	• Class size		
	• Laboratory accommodation		
	• Insufficient qualified teaching staff		
	• Insufficient trained technicians		
	• Other *(please specify):*		
Q31	Whether or not you are currently happy with the quality of learning you are able to provide in science please identify any shortfalls in resources *(please tick any which are relevant and put all ticked items in order of importance with 1 being the most important)*	***Tick***	***Rank***
	• None		
	• Basic science equipment to provide class sets or for demonstration		
	• Replacement of larger items of equipment		
	• New larger items of equipment		
	• Consumables		
	• Text books for each pupil		
	• Appropriate written resources for teaching and/or technical staff		
	• Videos		
	• IT Software		
	• IT hardware		
	• IT consumables		
	• Photocopying/ printing		
	• Other *(please specify)*		

Q32 If, suddenly, you had a sufficient sum of money available, what would be your **first** priority to spend it on?

Q33 Please add here any comments you wish to make about the sufficiency of funding to help you provide effective teaching and learning.

Thank you for your help with this questionnaire. Please return as soon as possible in the freepost envelope.

Appendix 3.2 Questionnaire response rate by types of respondent

Total number of forms sent out: 1654.

Total number of forms returned: 433

Percentages are rounded to the nearest whole number.

	Nº of forms returned	% of total returns
Type of school		
Comprehensive	284	66%
Secondary modern	13	3%
Grammar	21	5%
Specialist (all ability)	110	25%
Specialist (restricted ability)	2	0%
Other	3	1%
Total returns	433	100%
Age range of school		
11-16	162	37%
11-18	245	57%
14-18	15	3%
Other	11	3%
Total returns	433	100%
Status of school		
Community	294	68%
Foundation	68	16%
Voluntary aided	66	15%
Voluntary controlled	5	1%
Total returns	433	100%
Spending level of LEA		
High	91	21%
Medium	185	43%
Low	157	36%
Total returns	433	100%
Forms completed by		
Science teacher	284	66%
Science technician	139	32%
Other	10	2%
Total returns	433	100%

Appendix 3.3 Science department spending

Current financial year *(average sum rounded to nearest pound.)*

Financial allocation 2003 - 4	Average sum total	Range in total sum		Average per pupil	Range in sum per pupil	
All schools	£10 560	£1030	£40 000	**£9.89**	£0.64	£71.43
Comprehensive	£9 962	£1030	£36 500	£9.32	£0.64	£20.61
Spec. (all ability)	£11 584	£1 400	£40 000	£10.00	£1.08	£71.43
Spec. (restric. abil.)	£16 688	£12 000	£21 376	£18.70	£8.89	£28.50
Grammar	£14 851	£6 129	£31 500	£16.20	£8.59	£31.34
Secondary modern	£7 520	£3 250	£14 000	£9.76	£6.00	£22.22
Other	£8 648	£2 000	£17 056	£9.96	£3.85	£18.36
11-16	£7 683	£2000	£19 000	£8.78	£2.96	£18.47
11-18	£12 374	£1 030	£40 000	£10.66	£0.64	£71.43
14-18	£12 194	£6 000	£22 600	£9.17	£4.62	£14.95
Other	£10 237	£5 000	£22 000	£9.99	£6.33	£15.94
Community	£10 267	£1030	£36 500	£9.49	£0.64	£25.00
Vol. controlled	£11 495	£3 500	£18 000	£11.40	£5.00	£18.95
Voluntary aided	£10 307	£2 000	£40 000	£10.78	£3.33	£71.43
Foundation	£12 003	£1 400	£26 000	£10.64	£1.08	£28.50

Last financial year *(average sum rounded to nearest pound.)*

Financial allocation 2002 - 3	Average sum total	Range in total sum		Average per pupil	Range in sum per pupil	
All schools	£10 483	£1 030	£47 000	**£9.83**	£0.64	£51.65
Comprehensive	£10 056	£1 030	£47 000	£9.52	£0.64	£51.65
Spec. (all ability)	£11 301	£1 750	£36 000	£9.52	£1.09	£20.87
Spec. (restric. Abil.)	£19 142	£16 000	£22 284	£20.78	£11.85	£29.71
Grammar	£13 857	£6 129	£28 500	£15.19	£8.47	£28.36
Secondary modern	£6 135	£4 400	£12 000	£8.36	£6.36	£21.51
Other	£9 264	£4 236	£17 056	£11.27	£7.30	£18.36
11-16	£7 712	£2 500	£17 615	£8.82	£3.16	£20.72
11-18	£12 198	£1 030	£47 000	£10.49	£0.64	£51.65
14-18	£12 354	£6 000	£24 000	£9.29	£4.62	£20.87
Other	£10 701	£5 000	£22 000	£10.33	£6.33	£14.80
Community	£10 195	£1 030	£47 000	£9.40	£0.64	£51.65
Volunt. controlled	£13 063	£6 000	£18 000	£13.12	£8.00	£20.72
Voluntary aided	£10 022	£2 500	£28 500	£10.53	£4.46	£28.36
Foundation	£11 979	£1 750	£27 000	£10.70	£1.09	£29.71

Appendix 3.4 Spending by LEA type

Current financial year *(average sum rounded to nearest pound.)*

Financial allocation 2003 - 4	**Average sum total**	**Range in total sum**		**Average per pupil**	**Range in sum per pupil**	
Low Spending LEAs	£10 437	£1030	£40 000	**£9.89**	£0.64	£71.43
Medium Spending LEAs	£10 439	£1400	£36 500	**£9.58**	£1.08	£28.50
High Spending LEAs	£11 018	£3 000	£24 250	**£10.66**	£3.33	£20.61

Last financial year *(average sum rounded to nearest pound.)*

Financial allocation 2002 - 3	**Average sum total**	**Range in total sum**		**Average per pupil**	**Range in sum per pupil**	
Low Spending LEAs	£10 237	£1030	£36 606	**£9.62**	£0.64	£28.36
Medium Spending LEAs	£10 405	£1 750	£47 000	**£9.49**	£0.80	£51.65
High Spending LEAs	£11 114	£1 800	£23 550	**£10.84**	£3.33	£27.36

Appendix 3.5 Sufficiency of funding for science departments

Total number of responses = 433

Percentages are rounded to the nearest whole number.

Sufficiency of funding	Sufficient funding to provide an effective standard of science education		Insufficient funding to provide an effective standard of science education	
	Number of schools	% of schools	Number of schools	% of schools
All schools	40	9%	393	91%

Sufficiency of funding	Sufficient funding to provide an effective standard of science education	Insufficient funding to provide an effective standard of science education
	Number of schools	Number of schools
Comprehensive	24	260
Specialist (all ability)	11	99
Specialist (restricted ability)	1	1
Grammar	3	18
Secondary modern	1	12
Other	1	2
11-16	10	152
11-18	27	218
14-18	1	14
Other	2	9
Community	28	266
Voluntary controlled	0	5
Voluntary aided	9	57
Foundation	3	65

Appendix 3.6 Impact of LSC funding

Total number of responses = 243

Percentages are rounded to the nearest whole number.

Impact of LSC funding	Has made an impact	% of total responses	Has not made an impact	% of total responses
All schools	27	11%	216	89%

Impact of LSC funding	Has made an impact	Has not made an impact
Community	15	134
Voluntary Controlled	1	3
Voluntary Aided	3	38
Foundation	8	41

Only 5 of the 243 responses indicated that funding had improved subsequent to LSC funding being implemented. (2%).

Appendix 3.7 Method of allocation of funding

Total number of responses = 422

Percentages are rounded to the nearest whole number.

Allocation of funding	School formula		Annual departmental bid		Combination of formula and bid	
	Number of schools	% of total	Number of schools	% of total	Number of schools	% of total
All schools	229	54%	47	11%	146	35%

Allocation of funding	School formula	Annual departmental bid	Combination of formula and bid
Community	156	34	95
Voluntary Controlled	4	1	0
Voluntary Aided	34	7	24
Foundation	35	5	27

Appendix 3.8 Items which science department budgets have to cover

Total number of responses to this questions = 433

Percentages are rounded to the nearest whole number.

Item to be covered by budget	Percentage of science departments in which this applies
Textbooks	97%
Health & safety equipment	96%
Capital science equipment replacement	94%
Printing & photocopying	93%
ICT software	88%
Laboratory support equipment replacement	75%
Cost of service subscriptions	56%
ICT hardware	55%
Recurring annual maintenance costs	49%
Cost of subscriptions to professional bodies	48%

Individual schools may also require science departments to cover other items not mentioned in the above list.

Appendix 3.9 Major inhibiting factors in provision of a good quality of learning

Total number of responses to this question = 390

Factor	Number of responses indicating this as major factor (ticked, ranked or commented upon)	% of responses indicating this as major factor (ticked, ranked or commented upon)
Budget allocation	348	89%
Class size	286	73%
Laboratory accommodation	278	71%
Provision of trained technicians	151	39%
Provision of qualified teaching staff	105	27%

Others identified unprompted: ICT provision, curriculum pressures and initiative overload, availability of space (preparation, teaching, storage etc), pupil behaviour, poor management by senior staff and lack of funding for staff training.

Appendix 3.10 Major resourcing shortfalls

Total number of responses to this question = 428

Shortfall in resourcing	**Responses indicating this as major factor (ticked, ranked or commented upon)**	
	Number	**%**
ICT hardware	339	79%
Replacement of large items of equipment	329	77%
Purchase of new large items of equipment to keep up to date	318	74%
Textbooks	297	69%
ICT software	257	60%
Basic science equipment	182	43%
ICT consumables	136	32%
Photocopying & printing	126	29%
Videos	98	23%
Consumable items	96	22%
Written resources for staff	75	18%

Others identified unprompted: other audio-visual resources, storage and space, finance for training, finance to ensure planning time, finance for trips, finance for technician support.

Appendix 3.11 ICT availability to pupils

Type of school / LEA	Average number of pupils per science desktop	Average number of pupils per science laptop
All schools	133	267
Comprehensive	136	336
Specialist (all ability)	126	196
Specialist (restricted ability)	175	66
Grammar	130	209
Secondary modern	172	195
Other	97	0
11-16	115	350
11-18	145	268
14-18	117	134
Other	155	100
Community	133	289
Voluntary controlled	194	202
Voluntary aided	117	306
Foundation	147	190
Low-spending LEAs	137	284
Medium-spending LEAs	137	232
High-spending LEAs	119	311

111 schools have no science desktop computers at all. The range was from 0 to 120.

256 schools have no science laptops at all. The range was from 0 to 62.

Appendix 3.12 ICT availability to science staff (teaching and technicians)

Type of school / LEA	Average number of desktops available in prep rooms etc	Average number of laptops available in prep rooms etc
All schools	2.19	2.46
Comprehensive	2.05	2.42
Specialist (all ability)	2.42	2.79
Specialist (restricted ability)	3.00	3.00
Grammar	3.33	2.00
Secondary modern	1.75	1.67
Other	1.00	0.67
11-16	1.69	2.06
11-18	2.49	2.63
14-18	2.61	3.85
Other	2.30	2.9
Community	2.23	2.66
Voluntary controlled	2.00	0.8
Voluntary aided	1.75	1.32
Foundation	2.49	2.88
Low-spending LEAs	2.34	2.36
Medium-spending LEAs	2.12	2.76
High-spending LEAs	2.02	2.16

44 schools have no science desktop computers for staff at all. The range was from 0 to 20.

146 schools have no laptops at all for staff. The range was from 0 to 20.

Appendix 3.13 ICT networking facilities in science

The table shows the average percentage of laboratories which are networked for ICT in various types of school / LEA.

Percentages are rounded to the nearest whole number.

Type of school /LEA	**% of networked laboratories**
All schools	52%
Comprehensive	50%
Specialist (all ability)	56%
Specialist (restricted ability)	43%
Grammar	60%
Secondary modern	56%
Other	20%
11-16	51%
11-18	54%
14-18	41%
Other	44%
Community	50%
Voluntary controlled	43%
Voluntary aided	55%
Foundation	58%
Low-spending LEAs	49%
Medium-spending LEAs	59%
High-spending LEAs	46%

Laboratories, Resources and Budgets

A Report for the Royal Society of Chemistry on Provision for Science in Secondary Schools

Part 2

Appendices containing Resources Lists

These are included as Excel files on the CDROM included with this report