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SBS 04/01

SBS Survey of Secondary School Science Teachers

January 2004

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Summary

There were three components to our research, carried out over the past year:

- a focus group discussion with science and mathematics teachers
- various parliamentary questions[1]
- the main component of this report, a questionnaire distributed to heads of science departments in English secondary state schools

The significant results produced by the questionnaire are summarised here:

- In over three out of four schools students were sometimes unable to carry out practical lessons. The most common reasons for this, affecting 40-50% of respondents were:
  - student behavioural problems
  - lack of appropriate equipment
  - class sizes
- Funding for larger items of equipment was described as less than adequate in 65% of schools. This compares to 48% for ICT equipment and 29% for consumable items.
- Three in five teachers felt that laboratory facilities effected recruitment at their own school. Positive effects on recruitment and retention were noted at schools where facilities had recently been upgraded.
- Nearly nine out of ten respondents felt that there were problems with the current methods for assessing students' practical and investigative skills.
- The two most commonly cited issues were a lack of time and the emphasis on formulaic, prescriptive projects. Other issues raised included a lack of emphasis on practical skills.
- 29% of teachers wanted more contact hours for their pupils.
- There was much strong opinion but little consensus as to how the numeracy required for science should be distributed between maths and science lessons, although the majority felt it should be shared between both departments.
- Over a third of respondents feel they are currently spending more time teaching mathematics than is appropriate.

[1] See Appendix 2, page 22

Questionnaire Results

Introduction

SBS regularly interacts with those working in school science education. We talk to teachers, pupils, suppliers, policy makers and researchers. We aim to address neglected issues, and this survey is intended as an exploratory study on subjects raised by those 'on the front line' in science education.

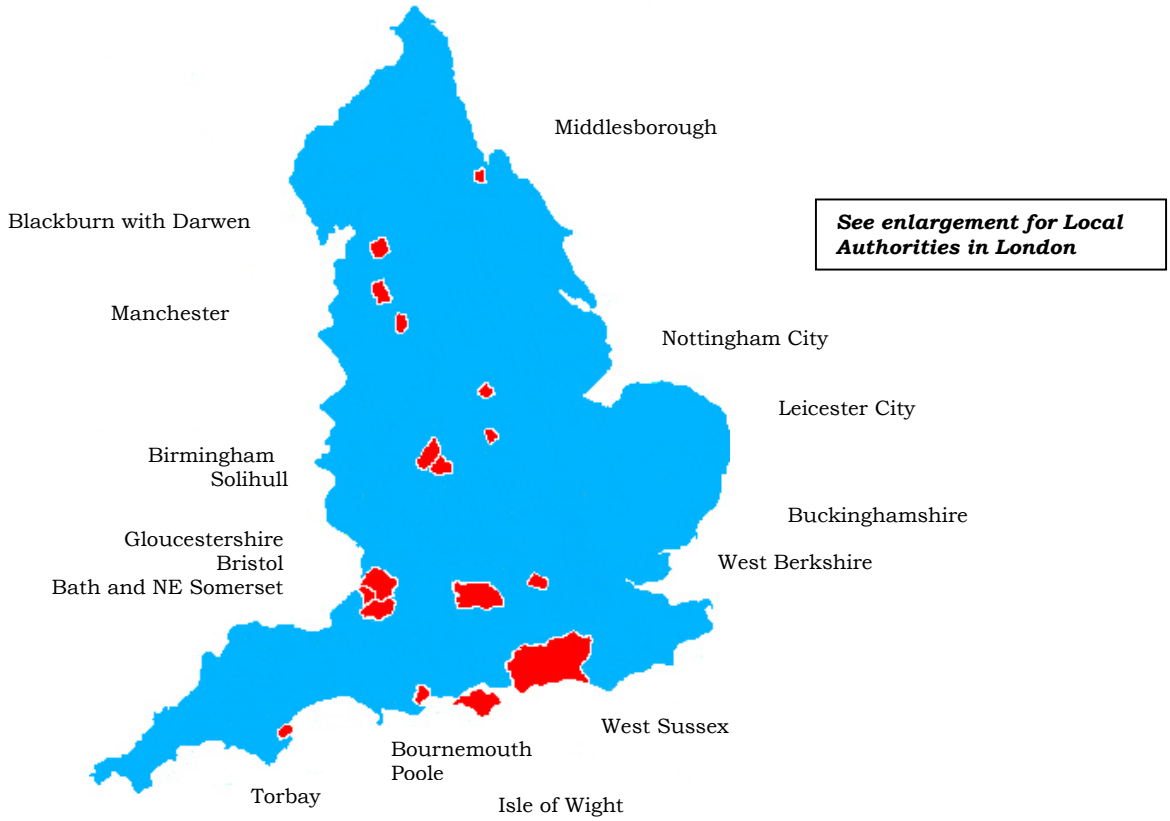
Following a report by the House of Commons Science and Technology Committee'[2], and our own survey of the Deans of Science, revealing that 47% of first year undergraduates are arriving without adequate practical skills for their courses of study[3], SBS wanted to gather further information on the condition of school laboratories and the way that practical classes are carried out. This report is restricted to English state secondary schools. We expect to carry out separate investigations on secondary school science in Scotland, Wales and Northern Ireland during 2004.

The first stage of our research was to hold a focus group *Views from the Blackboard* (*VFB)*, on 22.March 2003[4]. This provided us with some qualitative understanding of the issues, and was used to define and clarify the content of our questionnaire. The questionnaire was then used to determine how widespread the problems were, and help us determine which of the issues raised at *VFB* were most significant.

The questionnaire was sent to the Head of Science in all state schools in the LEAs shown overleaf, which we feel represent a reasonable geographic spread. We received 67 responses by the deadline of 25.July 2003. A copy of the questionnaire can be found in Appendix 1.

Full data available on request.

[2] Third Report of the Science and Technology Committee, House of Commons, July 2002
[3] http://www.savebritishscience.org.uk/texts/documents/2003/SBS0313.htm
[4] see www.savebritishscience.org.uk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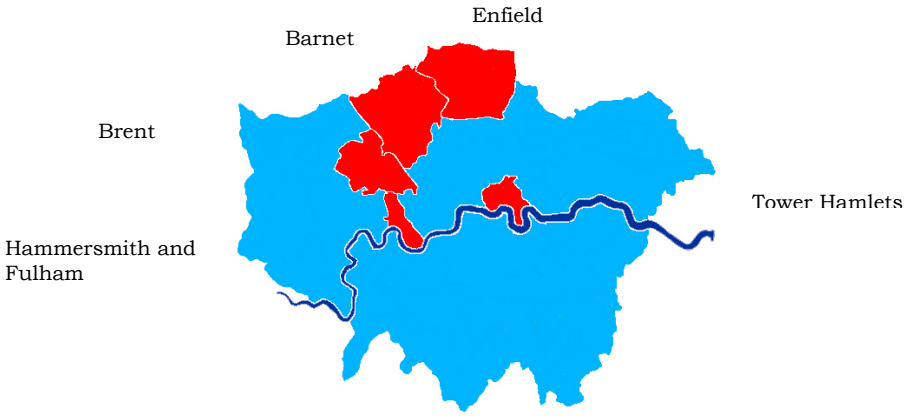
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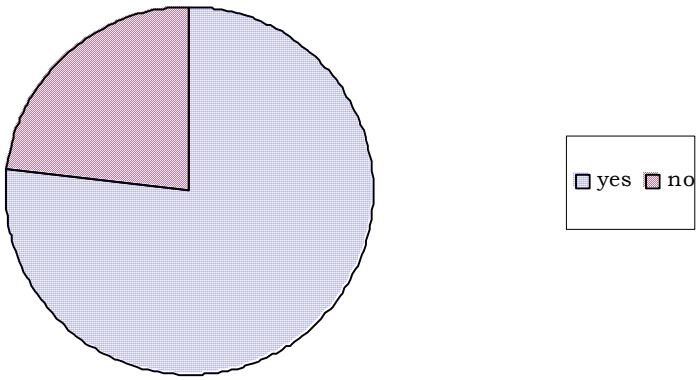
Section One
Practical Classes

At *VFB*, it was suggested that there were significant problems with the cancellation of practical classes due to factors such as behavioural problems and difficulties in replacing larger items of lab equipment. In one letter SBS received from a GCSE student the issue was raised again, that '*practicals were reduced to a minimum,…and the system did not always work smoothly, resulting in a cancelled session*'. We wanted to find out more about why practicals were being cancelled, and if the problem was widespread. So we asked:

Are your students ever unable to carry out a practical which would otherwise form part of the course?



- 77% of respondents were unable to carry out practical lessons at some point.
- The main reasons sited for this were behavioural problems, lack of equipment and class size.

Respondents were asked whether or not each of the following factors meant that their students were unable carry out practicals which would otherwise be part of the course. These are the results[5]:

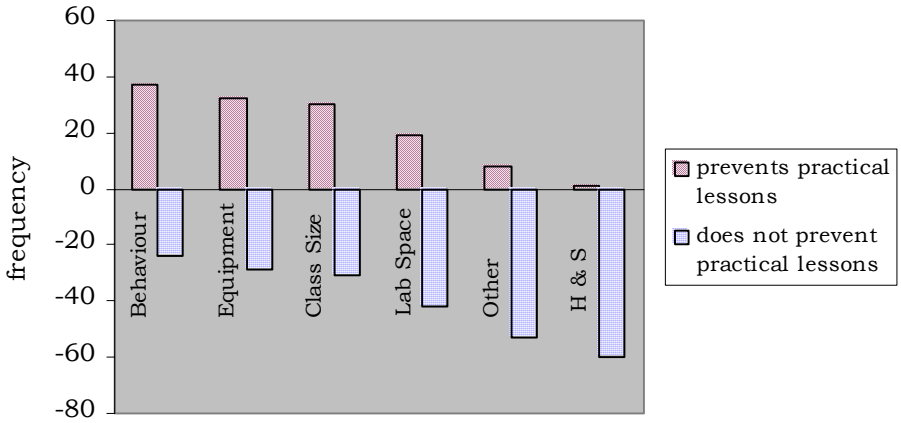
A: For 57% of respondents practicals were prevented by behavioural problems
B: For 49% of respondents practicals were prevented by a lack of equipment
C: For 46% of respondents practicals were prevented by class size
D: For 29% of respondents practicals were prevented by a lack of laboratory space
E: For 13% of respondents practicals were prevented by other reasons
F: For one respondent practicals were prevented by health and safety concerns

The data collected here indicates to us how widespread the cancellation of practicals is, and what the most common reasons for it are. It may also be worthwhile investigating the *frequency of cancellations*, as well as how far each of these factors may be detrimental to the *quality* of practicals.

It would be hard to set an exact figure for an 'acceptable' proportion of schools to be cancelling practical lessons, but the current 77% suggests that this is a serious problem.

[5] Figures shown represent the percentage of all respondents; who were invited to list all factors that apply.

Factors preventing practical lessons



A: Behavioural Problems - 57%

- It is surprising that such a high proportion of schools were actually *prevented* from carrying out practicals for this reason. The proportion of schools where behavioural problems *disrupt* practicals must be even higher.
- Perceptions of student behaviour was cited by teachers in our focus group as one of the most significant deterrents for anyone considering a career in teaching. It may be that this has an even more significant impact on practical subjects like science.
- Excluding the most difficult students can be very costly for schools.
- In a letter SBS received from a GCSE science student, the disruptive behaviour of other students was cited as a cause for concern, particularly when it was necessary to share materials.

B: Lack of Equipment – 49%

- The questionnaire included further questions on the state of laboratory equipment. We asked teachers whether their departments were adequately funded, on a scale of 1-5, for consumable supplies, larger items of lab equipment, and ICT.
- Only 31% described funding as "more than adequate" in *any* of the three areas. Only 17% described funding for *all areas* as "adequate" or better.

	Proportion describing funds as less than adequate:
Consumables:	29%
Larger items:	65%
ICT:	48%

- Two of our respondents provided further comments on this issue:

> *Funding has always been generous at our school. However, this year there is virtually no money available. A usually well resourced lab will rapidly run into problems under the new funding from Government.*

> *We have stopped buying cylinders of argon and nitrogen [laboratory chemicals] because of a reduction in budget over the years.*

- It was suggested during our focus group that there were particular difficulties finding funds for larger items which only needed replacing every few years, because schools are not allowed to carry their budgets over from one year to the next, and

there is never enough in a single year's budget to cover the replacement of these items. This can make it impossible for schools to replace more expensive items. As one teacher commented:

> *There is no account of depreciation for capital items.*

Comparison of the first two distributions below highlights the significance of this issue. Only 3% of respondents felt they were better funded for large items than they were for consumables.

- One teacher at a specialist science school[6] explained to SBS that:

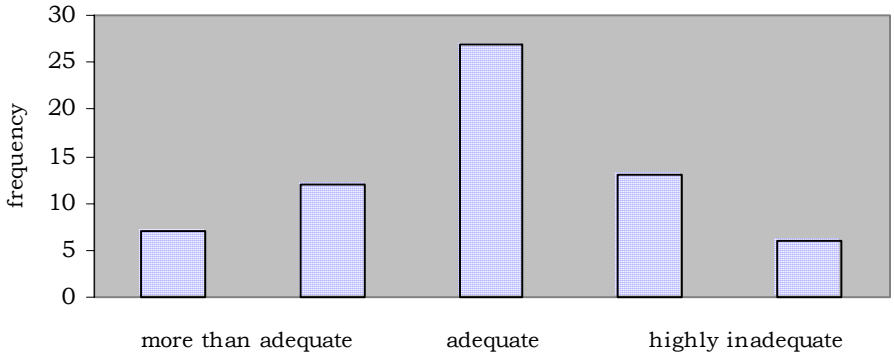
> *The larger items are purchased on a less frequent basis but are identified according to the needs of the department. The science curriculum area were provided with £20000 of new equipment two years ago, following years of under- funding in terms of replacement equipment.*

another commented that:

> *Our department is only [well funded for ICT equipment] because we have science college status.*

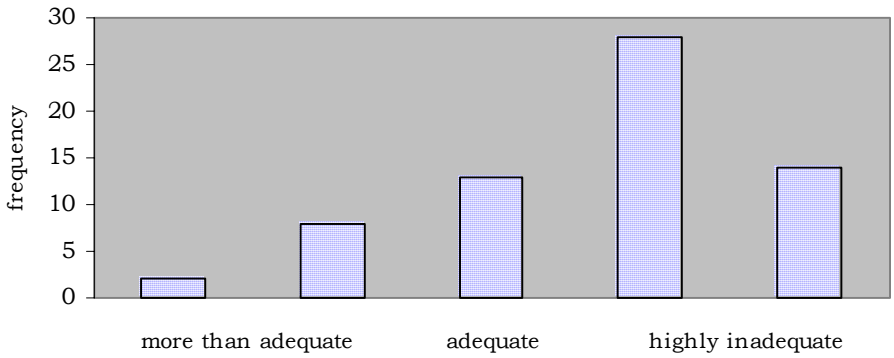
- ICT initiatives have so far been whole-school, so few science departments have been able to purchase their own computers. This goes some way to explain the shape of the distribution shown overleaf.

How well funded is this department for consumables?

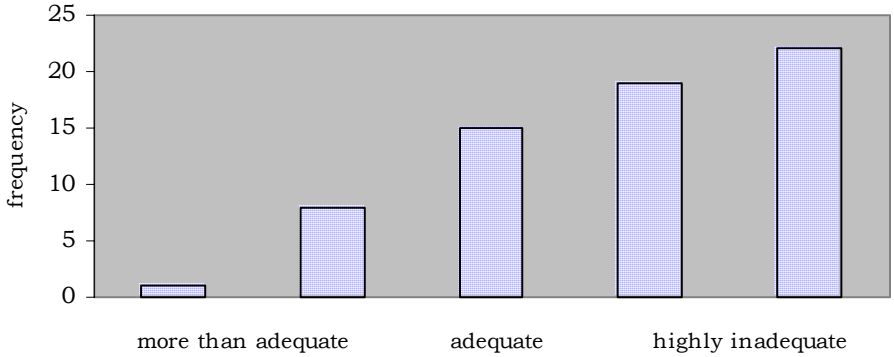


[6] At present 11 specialisations are available to schools. At the time of publication 121 out of 1457 specialist schools (8%) were specializing in science.

How well funded is this department for larger items?



How well funded is this department for ICT?



C: Class Sizes - 46%

- Nearly half of respondents were cancelling practicals because class sizes were too big. One respondent linked this issue directly to funding problems:

> *Class sizes are increasing, some year 7 classes now have 30 or 31 students. Insufficient budget (£6500 p.a. for school of 1100), and needy students in too large groups.*

  This comment also highlights the detrimental effect that large class sizes can have on the quality of the practicals which are carried out.
- A reduction in class sizes could be one step towards resolving the more widespread issue of behavioural problems. 66% of those who had to cancel practicals due to class size also had to cancel due to behavioural problems, a higher percentage than for other respondents.
- In Scotland there is a cap at 20 on class sizes for practical lessons. Scottish science teachers who spoke to SBS earlier this year commented that this is very helpful.

D: Lack of laboratory space – 29%

- Lack of lab space is a strain on teachers who may have to share their laboratories, but in most schools it does not prevent practicals from taking place. One

respondent commented that when there is a lack of space classes can 'double up' in order to work around the problem.

- As well as listing 'lack of lab space' as a factor which might prevent practicals from taking place, the questionnaire included three other questions on this issue. We asked respondents to tell us how many students were studying at KS4 and at VIth form level, and how many laboratories there were in each school. We also asked how often there was no laboratory available for science lessons.
- At *VFB* it was suggested that:

> *In some schools there are simply not enough labs to accommodate all science lessons. (With changes to school budgets this may become even more of a problem).*

However, the questionnaire data did not support this as any more than a problem of convenience.

- The table below indicates that for 85% of classes less than 10% of lessons take place without access to a laboratory.

Lessons which take place without access to a laboratory	Frequency		
	KS3	KS4	VIth Form
0%	36	28	17
0-10%	23	27	15
10-20%	4	7	7
20-30%	2	1	5

It is unclear, given the percentage of lessons when most teachers are unable to use a laboratory, why a lack of laboratory space should prevent practicals in such a substantial proportion (29%) of schools.

- No correlation was found between the number of lessons where students were unable to use a laboratory, and the number of laboratories per GCSE student.
- For schools without a VIth form, the number of labs per GCSE student varied considerably.
- We received the following comments, which indicate that a lack of laboratory space is perceived as a real problem by some teachers. It would be worth further investigation.

> *Another lab would be helpful as I have 7 science teachers and only 5 labs. This year out of the 30 lessons 14 had a class out of a lab and teachers had to teach in different labs and not have their own.*

> *Main concerns are: lab space inadequate/ group size too large; over full curriculum leading the squeezing out of 'fun' and practical*

E: Other factors preventing practical classes – 13%

- As well as the five possible reasons which were listed in the questionnaire [student behaviour, lack of equipment, class sizes, lack of lab space], the following factors were raised as reasons for cancelling practical lessons:
- **Technicians - 7 respondents:**
  It was mentioned that:
  - salaries are too low
  - jobs are vulnerable to budget cuts
  - there is a lack of candidates

- **Time constraints[7] - 4 respondents:**
  It was mentioned both that it is not always possible to complete practicals during the timetabled hours and that the large amount of syllabus content does not leave enough time during the course for practical classes.

  > *We like to ensure that practical tasks have challenges in them. Sometimes we do not have time to do them properly (50 min.s)*

- **CPD for teachers - 2 respondents:**
  Two comments highlighted the need for training of teachers in using computerised experimental techniques. It was also mentioned at *VFB*, that new technologies are underrepresented in practical classes and teachers are not trained to understand them.

F: Health and Safety

It was suggested during *VFB* that school management need to be better informed about the value of science experiments and the risks involved. In some cases perception of risk has led to disagreements about potentially valuable experimental work. However only one questionnaire respondent found that this was a problem.

Student Group Sizes

We asked teachers about how their students shared equipment during practical sessions. It had been suggested to us that the sharing of equipment can cause problems: for assessing individual students, when students are uncooperative, and simply because it reduces the opportunities for learning and using practical skills.

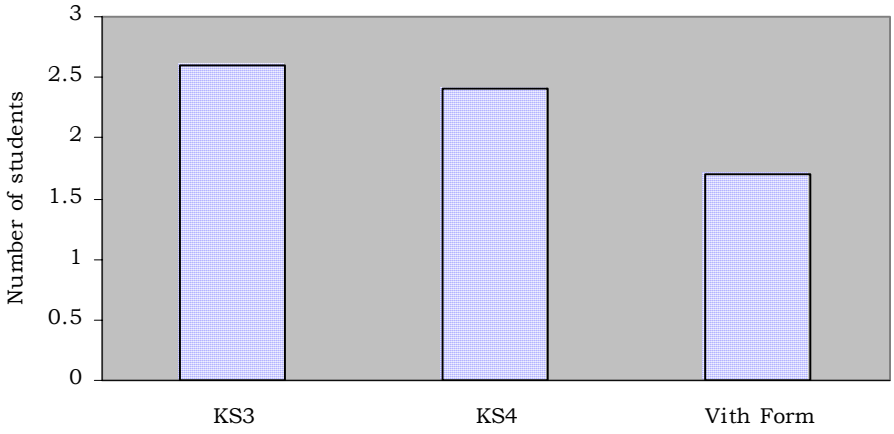
The results do not suggest that there is a significant problem in that students have to share equipment in unmanageably large groups. It appears that science teachers generally do not feel that it would be helpful to work around problems such as equipment shortages simply by encouraging students to share in groups larger than 4. However, there are very few students who are able to work mainly individually.

Frequencies are shown in the table below, while the graph overleaf illustrates the average across all respondents.

Students working mainly:	KS3	KS4	VIth Form
Individually	0%	5%	37%
in pairs	48%	59%	52%
in groups of 3	42%	28%	9%
in groups of 4	8%	7%	0%
in groups >4	2%	2%	2%

[7] For further results on lesson times see Section Four, page 16

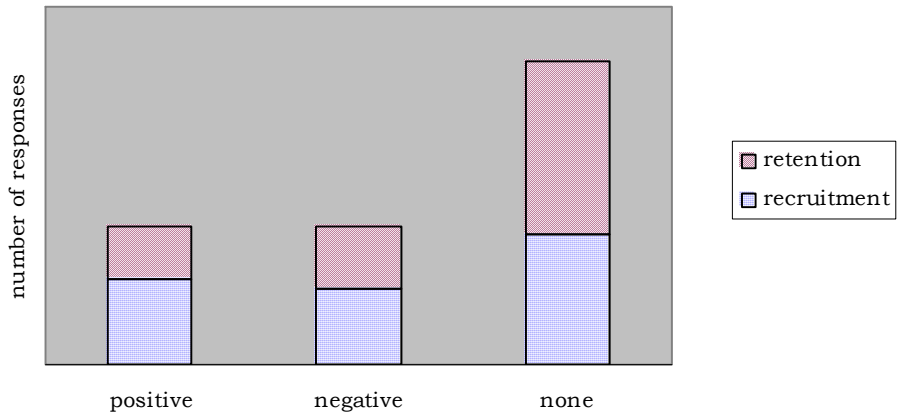
Group sizes for practical work



Section Two
Do laboratory facilities affect teacher recruitment and retention?

A good science teacher is probably the most important aspect of anyone's science education. Teacher shortages are also one of the worst problems for science at the moment. Since these issues are so important it seemed worth asking about the relevance of the condition of laboratories.

What effect do laboratory facilities have on recruitment and retention of staff in your department?



55% of respondents thought that their laboratory facilities had an affect on the recruitment of staff, while only a minority of 40% thought that their facilities effected retention. There was roughly even split as to whether the facilities at each particular school had a positive or a negative effect. This may reflect a variation in the standards of laboratory facilities in some areas. In a few cases were facilities had recently been upgraded positive effects were noticed. One respondent commented that:

> *Our facilities have a positive effect on recruitment since our laboratories were recently refurbished.*

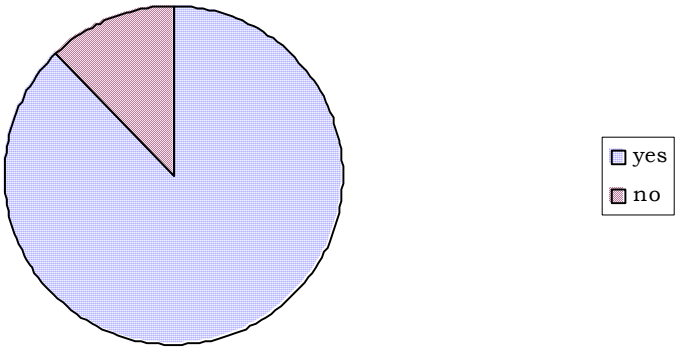
At *VFB* it was suggested that problems of teacher recruitment were primarily due to workload, perceptions of student behaviour, and to the bad image of science teaching as a profession. It is worth bearing in mind that the quality of laboratory facilities may have some effect on this image.

Section Three
The Assessment of Practical Skills

At *VFB* we discussed various issues around the coursework component of GCSE Science. Two main problems were raised: firstly, that there is not enough emphasis on *practical* skills compared to planning or writing skills; and secondly, that the marking system is unfair and open to abuse.

We decided to include a request for comments on this issue in our questionnaire, in order to assess the consensus on these issues, without influencing responses.

Do you feel that there are problems with the existing methods used for assessing practical skills and investigation skills?



Question 8 provoked a strong response[8]. As one teacher put it, 'it's time for a rethink'. 88% of respondents felt there were problems, and all of these provided explanatory comments. We grouped these into six general categories.

'Hoop jumping' or over-prescription (29%):
Many teachers complained that coursework assignments were merely a form of hoop jumping. This limited the choice of experiments that they were prepared to offer to students, and meant that the practicals were set out according to a formulaic pattern. We also received comments on the more widespread issue:

> *The pressure to get good value added results at KS3- A2 level is distorting results. We are not simply an exam factory but we feel the pressure to become one.*

> *Science is becoming less exciting with less problems solving- main reason is too many exams- yrs 9, 10, 11, 12 and 13- all extend exams.*

> *My main concerns are that lab space is inadequate or group size too large; and the over-full curriculum leading to the squeezing out of 'fun' and practical.*

Lack of time (29%):
This was either in terms of time for students to work or time for teachers marking. In both cases exam boards were blamed by some respondents; either for not taking on enough of the work in marking and moderating coursework activities, or for overloading

[8] See Appendix 3, page 26

other parts of the curriculum so that students could not develop their skills in advance of the assessment.

Too much content impinges on the available time to develop practical skills and then apply them to investigative work.
Far too much teacher time needed: we are unpaid markers for GCSE and A-Level coursework!

Marking inequalities (13%):
Respondents took a wide ranging approach to the problems associated with awarding marks for coursework assignments. Some referred to the way that practical, planning, evaluating and writing skills were dependent on each other for the assessment. Others mentioned that mark schemes were too vague or 'open to misinterpretation'. Several respondents also commented that coursework projects did not account for a wide range of abilities, or that the 'levels' of achievement are incompatible with 'levels' in exam papers, or that the 'levels' were even incompatible across scientific disciplines.

Not enough *practical* work (12%):
As well as a lack of time within the curriculum for 'practicals', some respondents raised the issue of a lack of *practical* skills involved in school syllabi. Some teachers commented that the emphasis was on planning, evaluating or written skills; while others suggested that the assessment of practical skills was limited by class size and a lack of equipment. Some teachers put forward suggestions on how to reorganise the assessment: that investigation skills be assessed through a written exam, while experiments should be used to assess purely practical skills.
Only one respondent commented but answered that there were no problems. This respondent suggested that assessed practicals be introduced in year 7, to provide students with the opportunity to develop the skills needed.

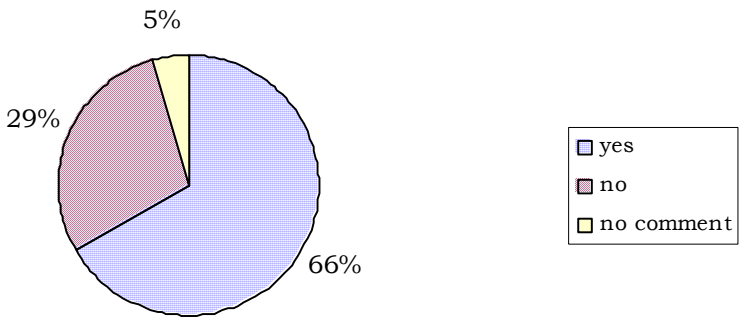
Cheating (8%)
Investigation write-ups are easily copied from older students or from the internet. This problem can be exacerbated by the lack of variation in practicals offered by exam boards or by needs of individual schools, who tend to choose the same practicals year after year.
Since resources must be shared during the practical, it is difficult to distinguish between students who are collaborating.

Range of skills:
While many respondents implied a lack of breadth in the types of investigation on offer, two respondents referred to particular problems in the biology syllabus.

Section Four
Time in Lessons

- We asked teachers how much time their students spend in science lessons and whether they thought this was adequate.
- Practical lessons fare particularly badly when there are time constraints.
- Lack of time is a factor which frequently mentioned in relation to issues such as teacher recruitment, syllabus content, coursework and practicals. It was the most frequently cited problem in response to our question on the assessment of practical skills[9]. This question looks specifically at the amount of time pupils spend in science lessons, [since this is most relevant to their experience of science practicals].
- There is no minimum requirement for the number of hours of science lessons that students should receive. Teachers have suggested to us that 2.5 hours (150 minutes) is appropriate at KS3, or that science lessons should make up 20% of the total.

Are the hours adequate?



- For all courses (KS3, GCSE and AS/A2), the average value of hours described as 'inadequate' is only insignificantly lower than the average value of hours described as 'adequate'.
- For those who answered 'no' to the above question, for Double Science GCSE, half were spending more than the average for those who answered 'yes'.
- We were surprised at the huge range of times quoted. Given there is such variation it is particularly surprising that there was no clear difference between the hours described as 'adequate' and the hours described as 'inadequate'.
- The ranges shown in all cases make it impossible to suggest a sensible value for the hours needed. It is hard to see any correlation between the 'objective' data of the number of hours and the 'subjective' data of adequacy[10].

[9] See Section Three, page 13
[10] For a fuller illustration of results see Appendix Five, page 30

Section Five
Mathematics and Numeracy

SBS's survey of the Deans of Science[11] revealed that on 70% of courses fewer than half of undergraduates arrive with the appropriate mathematical skills. Many different problems are associated with mathematics education, and these require detailed consideration. However, at the time of our survey SBS felt it would be worthwhile gauging teachers' opinion on just one specific issue: the balance between mathematics and science lessons for providing the numeracy required for science[12]. We included one question about how this issue *should* be organised, and one about the situation as it is at present.

The Cross- Curricular Numeracy Strategy (introduced in September 2001) has had some positive impact on this issue. SBS heard generally positive comments about the strategy, however there are still some problems. At *VFB* it was suggested that:

> *…the mathematical knowledge required for the science syllabus is still too great in some cases. The mathematics syllabus should be reformed to include more numeracy, and work where students can see the applications of mathematics.*

- 39% of respondents commented on these questions, without a prompt in the questionnaire[13]. The overriding message was that there is a need for coordination and communication between departments. Three respondents also mentioned the importance of students' awareness that their mathematical skills are transferable.
- 24% of respondents commented on the need for a fully cross curricular approach, the importance of coordination, cooperation, and an understanding of transferable skills.
- 12% of respondents commented on the importance of maths lessons for the science syllabus.
- Other comments included:

> *This should be coordinated at QCA level, so the maths supports the needs of science and other subjects.*

> *[The numeracy required for science is best taught] at KS1 & 2, and in maths & science. Numeracy is best taught… PROPERLY? …BY MATHS GRADUATES?*

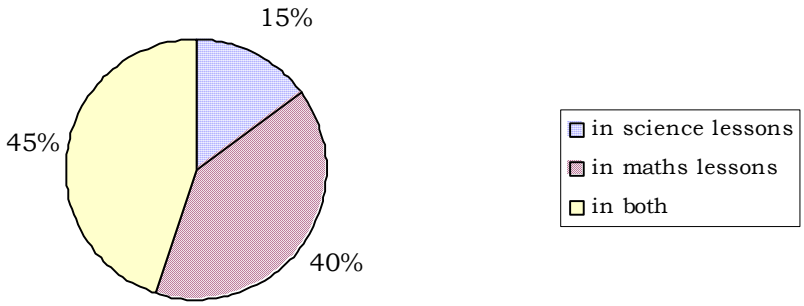
> *Lack of maths in many A-level students is very worrying*

[11] http://www.savebritishscience.org.uk/texts/documents/2003/SBS0313.htm

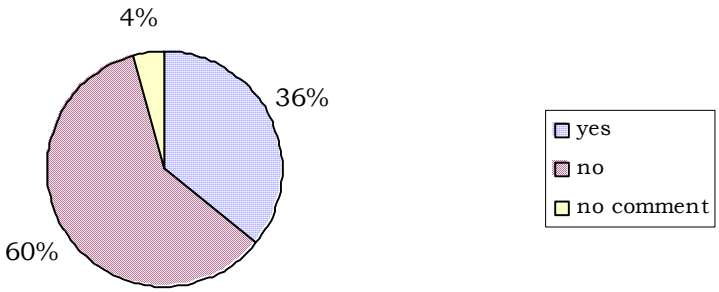
[12] When considering science teachers' responses here, it is interesting to note the finding of the Student Review of the Science Curriculum, that 61% of students think it is possible to do well in science without mathematics. http://www.scienceyear.com/sciteach/review/Findings.pdf

[13] See Appendix 4, page 29 for a full list of comments.

The numeracy required for science is best taught:



Science teachers in this school spend more time teaching maths than they feel is appropriate:



Analysis and Conclusions

Summary:

- Students should be able to carry out practicals which are intended to be part of the courses. It seems that there are several *ongoing* problems which prevent these activities.
- More research is required into the ways in which behavioural problems are effecting science education, and the ways in which this can be addressed. Our survey has shown that this is a widespread and significant issue in practical lessons.
- More funding needs to be put towards equipment supplies on an ongoing basis. This problem is most severe for larger items of equipment, partly due to their high cost, and partly because it is not possible for schools to carry funds over from one year to the next. Funding for ICT is also particularly poor. Funding initiatives should be extended to allow schools to purchase equipment for individual departments.
- In many schools class sizes are larger than ideal. SBS's future research in Scotland should provide some idea of the significance of this issue. This problem is difficult to resolve without an adequate supply of science teachers and better funding.
- Our survey provided ambiguous information on schools' requirements and conditions regarding laboratory space. This is an area worthy of further research.
- It is widely acknowledged that science coursework and assessment of practical skills is in need of a rethink. Our survey has indicated teacher opinion as to what the most important issues are: the quality of experiments on offer, the arrangements for marking, the time available to allow students to develop their skills, and the fairness of grading and assessment systems. The full list of comments in Appendix 3 also provides further insight into teachers' opinions.
- It was only a very narrow majority of respondents who felt that 'the numeracy required for science is best taught in both mathematics and science lessons'. Many science teachers feel that this should be responsibility of mathematics teachers. In terms of the current arrangements, again a substantial minority feel that the balance is tipped too heavily towards science lessons. This can cause particular problems for students choosing to pursue their science education further.

Appendices

Appendix 1

The Questionnaire

Thank you for taking the time to fill in this short questionnaire, which aims to gather basic evidence for some of the improvements and additional funding needed in secondary school science.

We will not reveal the identity of any individual, or of any institution, but will compile the results to give an overall picture.

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1. How many students in your school study each of the following:

GCSE Science(s)?	_____
A- level Biology?	_____
A- level Chemistry?	_____
A- level Physics?	_____

2. How many hours of science lessons do students receive each week during:

KS3?	_____
Single Science GCSE?	_____
Double Science GCSE?	_____

3. Do you feel these hours are adequate?

Yes / No

4. How many laboratories are there in your school?

_____

5. Roughly how often are you unable to use a laboratory to teach science lessons?:

	KS3	KS4	VIth form
Never	□	□	□
Less than 10% of lessons	□	□	□
10-20% of lessons	□	□	□
20-30% of lessons	□	□	□
Other (please specify)	_____	_____	_____

6. During practical lessons, do your students work mainly:

	KS3	KS4	VIth form
individually?	□	□	□
in pairs?	□	□	□
in groups of three?	□	□	□
in groups of four?	□	□	□
in larger groups?	□	□	□

7. Are your students ever unable to carry out a practical which would otherwise form a part of the course, due to:

a lack of equipment? ☐
a lack of lab space? ☐
class sizes? ☐
students' behavioural problems? ☐
attitudes of senior staff toward health and safety? ☐
other reasons? _____
_____
_____

8. Do you feel that there are problems with the existing methods used for assessing practical skills and investigation skills?

Yes/ No

Please comment:_____
_____
_____

9. How well funded do you feel your department is for:

	More than adequate		Adequate		Highly inadequate
	1	2	3	4	5
consumable supplies?	☐	☐	☐	☐	☐
large items of lab equipment?	☐	☐	☐	☐	☐
ICT equipment?	☐	☐	☐	☐	☐

10. What effect do you feel your laboratory facilities have on the employment of staff in your department?

	Positive effect	Negative effect	No effect
Recruitment of science teachers	☐	☐	☐
Retention of science teachers	☐	☐	☐

11. Do science teachers in your school spend more time teaching the mathematical techniques required for the science syllabus than they feel is appropriate?

Yes/ No

12. Do you feel that the numeracy required for science is best taught:

in science lessons? ☐
in maths lessons? ☐
other: _____
_____

Finally, we would be very interested to hear any other comments you have. Please feel free to add them on an additional sheet.

Appendix 2
Research on the Funding of School Laboratories

Background
The distribution of funds to school science laboratories is generally determined by individual schools and LEAs. One recent exception was a £60 million DfES scheme for the years 00-01 and 01-02 called *School Laboratories for the 21st Century*, part of the second round of the Treasury's *Capital Modernisation Fund*. The funding was only for capital projects, could not be used for equipment supplies.

The following announcement outlines the scheme:

> The aim is to raise pupil attainment and interest in science at all ages of secondary school. The project involves refurbishment or re-building science laboratories and modernisation with new equipment, including ICT. The project impacts on the motivation of pupils and teachers; allowing pupils to acquire new scope for pursuing projects outside their normal lesson periods and pursuing science in further and higher education. £60m will allow 21% of secondary schools "unsatisfactory or worse" science accommodation (OFSTED assessment) to be substantially refurbished. [14]

The OFSTED assessment referred to here[15] revealed that 750 schools had science accommodation that was 'unsatisfactory or worse', making up 21% of all the schools in England. The scheme was intended to enable around 400 projects. SBS's own survey of LEAs showed that funds were distributed more widely than this, and subsidised by other capital funding, see page 25. A more recent estimates made by OFSTED of the number of schools with 'unsatisfactory' science accommodation is around 26%[16].

Sufficiency of Funds:
The House of Commons Science and Technology Committee commented on the scheme:

> The £60 million was only ever expected to meet half the need. On the basis of their survey, the Royal Society estimate that additional funds of between £60 million and £120 million are required to bring all school laboratories in England up to an adequate standard. Taking OFSTED's most recent estimate of 905 schools with science accommodation so poor that it is affecting teaching, the amount needed is nearer £120 million. Considerably more investment would be needed to bring all schools to a good or very good standard.
> …
> It is not the intention of DfES to provide another tranche of money specifically for laboratories. Mr Timms told us that in 2002-03 there would be approaching £3 billion available for capital investment in schools. He said "we are moving...towards giving schools the decision about where that capital should be invested, and away from ring fencing; so I do not envisage another initiative like the £60 million initiative". We recognise that the quality of school laboratories varies widely and some schools do have excellent facilities and will want to focus resources in other areas. We also agree that in general it is best to give schools the freedom to decide their own priorities. However, we are concerned that in those schools with poor facilities, the costs associated with

[14] http://www.hm-treasury.gov.uk/Documents/Public_Spending_and_Services/Capital_Modernisation_Fund/pss_cmf_round2.cfm
[15] The Annual Report of Her Majesty's Chief Inspector of Schools 1999 http://www.archive.official-documents.co.uk/document/ofsted/hc102/102-01.htm
[16] Third Report of the Science and Technology Committee, House of Commons, July 2002 http://www.parliament.the-stationery-office.co.uk/pa/cm200102/cmselect/cmsctech/508/50802.htm

laboratory refurbishment are so high that schools will be reluctant to place this as a high priority. Additional funding would need to be targeted at these schools. We would not want to see a bureaucratic arrangement introduced where schools would have to bid for funds. DfES's decision to allocate the initial £60 million investment in laboratories to LEAs, who could then target the funding at those schools most in need, seems to us the most sensible way of allocating further funds. Once all schools have appropriate facilities for teaching science, funding for ongoing maintenance and refurbishment should not need to be ringfenced.
We recommend that, over the next three years, the Government ringfence a minimum of £120 million to bring all school laboratories and prep rooms up to at least adequate standard. This money should be allocated direct to LEAs so that it can be targeted at those schools most in need.[17]

They also wrote:

While we are persuaded that funding for capital investment in science should be ringfenced, we do not believe that this is practical, or desirable, for revenue funding in science. Schools should retain the autonomy over the allocation of their resources but should be provided with information on which to base their decisions on funding for science departments.

and:

In 1997, they [the Royal Society] estimated that schools were under-spending by about £2 per student per year and they believe that this is still likely to be the case now. They now estimate that schools in England need to spend an additional £6 million each year if their laboratories are to remain adequately stocked with functioning equipment and resources required to teach national curriculum science.[18]

Monitoring:
Although the funds were provided in response to assessment of individual schools by OFSTED, they were allocated to LEAs according to formula, 'in line with the department's [DfES's] policy of reducing bureaucracy and paperwork'[19].

Government has not carried out an evaluation of its own. DfES tell us that "the precise format of the evaluation is yet to be finalised, and we anticipate the report will be completed by next summer"*. We find it astonishing that, more than two years after announcing the investment of a significant sum of public money in school laboratories, DfES has not even decided how to evaluate the impact of these additional funds. We fail to see how DfES can make informed decisions about what further investment is needed without such evaluation. [20]

* That is, summer 2003. On 16.December 2002 it was suggested[21] that the report would be prepared by December 2003.

Over the next 12 months an evaluation report will be prepared covering a sample of the 149 participating local education authorities. This will provide details of how the funding has been invested, including what the balance is between newly constructed and refurbished laboratories, and an early indication of what impact this has had on educational standards.

The evaluation report was not available at the time this report was published.

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[17] See note 17
[18] These figures were calculated from their table of resources at http://www.royalsoc.ac.uk/education/, in combination with a survey of schools to estimate what was actually being spent at the time.
[19] Hansard: Jaqui Smith 19. July 2002.
[20] See note 17
[21] Hansard: Margaret Hodge 16. December 2002

Parliamentary Questions
Following up on the concerns raised in the Science and Technology Committee's report, SBS assisted Members of Parliament in drafting the following parliamentary questions[22], which were asked of the Secretary of State for Education and Skills on 20. Jan. 2003. Mr. David Miliband[23] reponded. The first question shown here relates to the insufficiency of the funds provided, while the second and third relate to the monitoring of the success of the scheme.

What provisions will be made for schools with 'unsatisfactory or worse' science accommodation that did not benefit from the funding made available through the School Laboratories for the 21st Century scheme?
The central government funding available for investment in school buildings will rise from £3 billion this year, to £3.8 billion for 2003–04, and will rise further to over £5 billion by 2005–06. The bulk of this funding is allocated by formula to schools and to local education authorities (LEAs) to support investment in their priority needs. LEAs have Asset Management Plans to prioritise these needs locally in a rigorous, open and consultative process, based on a full survey of the building needs of all their schools, including for science teaching and learning, and reflecting government priorities such as our aim to improve the provision of laboratories. Schools now receive substantial direct capital funding, to give them a direct stake in investment in their buildings, including in laboratories. A secondary school of 1,000 pupils will in 2003–04 receive about £75,000 of direct capital, and this funding can be rolled over for up to three years to allow major projects to be addressed.

The following question was asked because it was originally suggested that *School Laboratories for the 21st Century* would be monitored as part of the *Appraisal of Asset Management Plans*, but SBS could not find any information in previous *Appraisals* for comparison:

What information has the appraisal of asset management plans generated on the condition of accommodation and equipment in secondary school science laboratories?
The condition data that have been collected from local education authorities in connection with their asset management plans do not separately identify the condition of science laboratories or the equipment they contain. To have asked for spaces to be separately identified would have placed an undue burden on authorities.

The following question was asked because SBS was unable to find consistent national data from OFSTED on the condition of science laboratories and their funding varies from school to school. We considered such information to be relevant to discussion of the ringfencing of future funds.

What plans are there to ask OFSTED to monitor spending on schools' laboratories and equipment supplies in more detail than at present?
OFSTED as part of its general remit assesses the suitability of school building for delivery of the National Curriculum, including the sciences. There are at present no plans to ask OFSTED separately to monitor the spending on schools' laboratories and equipment supplies. Generally, we do not monitor details of capital investment at LEA level because of the bureaucratic burden that this would impose. An evaluation report of £60 million capital funding that was allocated to LEAs for the School Laboratories for the 21st Century scheme in 2000–01 and 2001–02, covering a sample of 149 participating LEAs will be prepared over the next 12 months.

[22] Hansard: David Miliband 20.July 2003
[23] Minister of State for School Standards and MP for South Shields

LEA Survey

- We contacted all 154 LEAs, requesting information on the distribution of their allocations from 'School Laboratories for the 21st Century'. We received useful responses from 21.
- In these areas, 119 out of 355 schools (i.e. 34%, roughly one third) had benefited from *School Laboratories for the 21st Century* funding. In one LEA were all schools given a share of the funding, while several had concentrated all funds at one school.

LEA	**Schools benefiting/ all schools**	**Additional comments recieved**
Barnet	3/ 21	
Bath and North East Somerset	1/ 12	All funds were allocated to the only co-educational, non-denominational school in the LEA. Following a failed NDS bid, other laboratories were refurbished using the LEA's existing capital programme.
Blackburn with Darwen	3/ 9	These improvements had to be subsidised by the LEA's existing capital programme.
Bournemouth	4/ 10	
Brent	5/ 14	
Bristol City	4/ 19	
Buckinghamshire	13/ 34	
East Riding of Yorkshire	7/ 18	In most cases Basic Need or other capital money was used to supplement the Labs money (only around 50% of costs were covered by this scheme).
Enfield	3/ 24	Staff at the LEA commented: 'This went nowhere near the desperate need to refurbish large numbers of school laboratories'.
Gloucestershire	25/ 42	
Hammersmith and Fulham	2/ 8	Funds were simply added to the existing capital programme.
Isle of Wight	1/ 5	
Islington	2/ 9	
Leicester City	5/ 16	
Middlesbrough	2/ 9	
Poole	1/ 8	Staff at the LEA commented on the choice to allocate all funds to a single school: 'because they were teaching in classrooms before.'
Solihull	13/ 13	A fixed sum was given to all schools in the LEA, plus an additional amount according to need. The £160k/yr was subsidised with £280k from the LEA's own budget and a £379 bid from DfES.
Torbay	4/ 8	
Tower Hamlets	5/ 21	
West Berkshire	8/ 16	
West Sussex	8/ 39	These improvements had to be subsidised by the LEA's existing capital programme.

Unfortunately we did not receive enough responses to our questionnaire to enable us to make significant comparisons between those schools which had benefited from *School Laboratories for the 21st Century* funding and those which did not.

Appendix 3
All responses received for Question 8

"Do you feel that there are problems with the existing methods used for assessing practical skills and investigation skills? Please Comment."

Too formulaic, not enough opportunity for pupils to show what they can do/know. Longer-term activities would be more meaningful.
Too didactic.
Too much content impinges on the available time to develop practical skills and then apply them in investigative work.
Investigations to be manageable are just routine and require hours of marking/moderating/entering marks etc.
KS4 coursework – series of hoops to jump through. Teachers pick the practicals for coursework to gain the highest possible grades.
Coursework criteria at KS4 are easily open to misinterpretation. No two examiners give the same interpretation of one of the descriptors.
Too many hoops to jump through. The old Nuffield A-level physics mark scheme was very good.
They are open to cheating, but difficult to think of another way to assess!
Many skills in biology not addressed by KS4 investigations.
Ensuring standard with coursework and practical exam at AS+A2 is difficult.
They are formulaic. They are not creative. Do not offer scope for differing standard skills to be valued.
Particularly AS/A2 Biology
Pupil collaboration leading to copying. Too little time. Difficulty of access for weak students. Much too much pressure on resources/space.
Curriculum is too content laden
Time for assessment
The assessment schemes are too prescriptive and the hierarchical structure prevents achievement being rewarded.
Scope for cheating is too great, e.g. use of internet. Pressure on staff too great excessive workload.
Amount of content for Sc2, 3+4 [biology, chemistry and physics] still high at KS4 especially. Not enough time available to develop sc1 [safety, practical and thinking] skills.
Practical skills are very limited – too little time to develop the skills due to the large amount of material to be covered.
Far too much teacher time needed – unpaid markers for GCSE and A-level coursework!
Too prescriptive – not enough freedom or excitement! Not enough time if the curriculum is to be covered.
The planning side makes it difficult to do exam practical investigation skills during lessons –this is done afterwards in the write up.
1 ½ actual practical 8 hours on plan analysis and evaluation written work.
Very formulaic – very prescriptive almost artificial coursework. The descriptions are not sufficiently different or hierarchical.
Too formulaic i.e. P/O/A/E [the four skill areas: plan, observe, analyse and conclude, evaluate]– despite attempts to free up the system. Little room for problem solving proper.
Too much jumping through hoops. Assessment of individual skills in lessons better as not opens to abuse by pupils copying off the internet.
Encourage narrowing types of investigation.
Examination Boards expect far too much by way of admin., marking, moderation and bureaucracy. We should just send the work to them for the whole process – we are their paying customers after all!
Seriously time consuming to mark and moderate.
In order to ensure top grades students have to jump through hoops: no 'real' science i.e. when the answer is not known in advance.
Lack of resources means demos rather than practicals.

A lot of jumping through hoops.
Close observation for assessment difficult while monitoring whole class.
Time
Too lengthly / pedantic assessment destroys interest in the subject.
Yes- we end up doing the same old tried and tested assessment experiments – other experiments might reduce opportunity for the students to access the highest marks.
GCSE – scheme favours physics can't get level 8 just on observations in chemistry practical. AS Nuffield Chemistry difficult for students the resist practical module because there are not enough published processing practicals from the exam board.
The present coursework arrangements for GCSE are hopeless. Everybody does the same investigation, little differentiation, not motivating, staff hate the marking, etc. etc. Time for a re-think.
Coursework for ATI component is very time consuming.
Far more dependent on their written skills than on practical abilities.
Too prescriptive; one size does not fit all. Real practical skills are not tested.
Too prescriptive.
Investigations tend to be closed at GCSE ad AS/A2. Standardisation on marking extremely difficult. Rigid hierarchical marks schemes for AS/A2 coursework.
'Practical skills' are hardly assessed. Skills P, A and E [planning, analysing and concluding, evaluating] could be assessed in written papers equally well!
I would like a science practical exam as well as coursework.
Cannot do it individually. Takes a large amount of curriculum time.
Too much is expected of staff. A level, AS and GCSE coursework all at the same time.
Too bureaucratic and time consuming. Very restrictive pupil experiments.
They are too much of a burden on staff who are already overworked.
Dependence on literary skills, inaccessible to low skill students.
[No problems] Just needs to be implemented at year 7 to get pupils used to it – i.e. continuation from Primary School.
Too open to abuse: - investigations can be downloaded from the web: - previous years students coursework can be saved on hard drive and then on to brothers, sisters, friends.
The criteria are a series of 'hurdles' you teach pupils to jump. Creativity is limited!
At KS3 criteria levels not compatible with theory levels and descriptions are too vague. Expectations are not realistic.
Prescriptive format. Unrealistic scenarios.
Paperwork is too time consuming .
Too large groups for thorough practical assessment- can only achieve through certain amount of discussion and by looking at recording. LA not always good at written detail.

Appendix 4
All responses on Mathematics and Numeracy

Do science teachers in your school spend more time teaching the mathematical techniques required for the science syllabus than they feel is appropriate?

Lack of maths in many A-level students is very worrying
ABSOLUTELY
Interesting question! Mostly 'no' but I suppose 'yes' sometimes

Do you feel that the numeracy required for science is best taught in maths or science lessons?

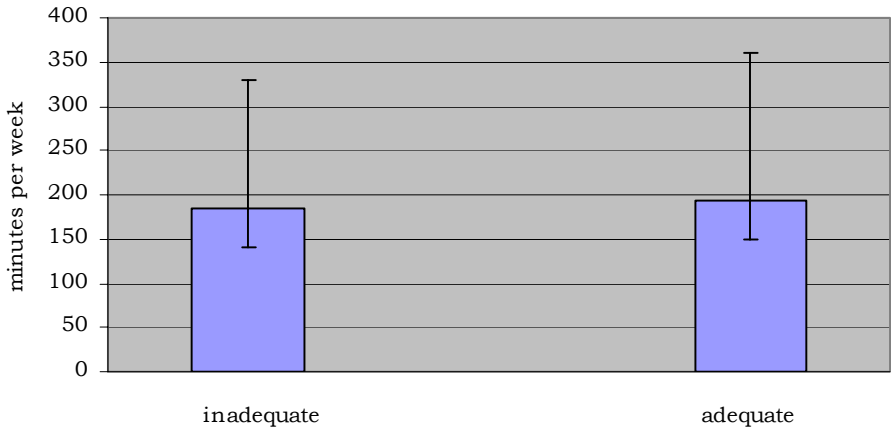
Both to emphasise transferable nature of skills
Across all subjects
Between both- need to work together to teach it
Should be both, we try to work side by side
I feel a coordinated approach would benefit the pupils far better!
A coordinated cross curricular approach
(both) Taught or implemented/practical
Cross- curriculum – geog/hist/langs etc.
In both to reinforce the strategies- cross curricular
Best taught as reinforcements for each other- maths and science departments cooperating
Mostly in maths but applications in science- just needs communication!
Both: initially in maths then applied in science
Numeracy should be taught in maths lessons, although I am happy to reinforce or revise methods, but not to teach them for the first time
Cross- curricular reinforcement of numeracy skills developed through maths lessons
In maths lessons but with liaison so that one reinforces the other.
Maths departments are happy to work with us when we introduce new formulae but the timing does not always work- we often introduce new mathematical concepts before they are covered in the maths national curriculum.
This should be coordinated at QCA level, so the maths supports the needs of science and other subjects.
At KS1 & 2, and in maths & science. Numeracy is best taught… PROPERLY? …BY MATHS GRADUATES?
Both, as with ICT. We often assume far too much is already known, e.g. pupils do ICT at KS1-4, but how many can type reasonably well? i.e. have low keyboard skills.
Pupils have the skills but don't see them as transferable
Pupils see subjects in separate compartments and do not think of transferring skills learnt in one subject to another
It would help if they didn't conflict, e.g. lines of best fit can be curves.
Depends on the teacher

Appendix 5
Questions 2 and 3

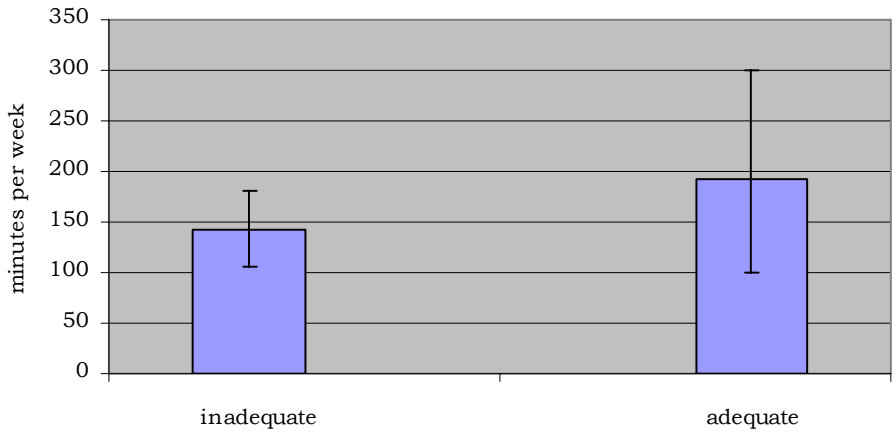
"How many hours of science lessons do students receive each week?"
"Do you feel these hours are adequate?"

The graphs below represent means, with the range between maximum and minimum times also shown.

KS3



Single Science GCSE



Double Science GCSE