The Save British Science Society
29-30 Tavistock Square, London, WC1H 9QU
Tel: 020 7679 4995 Fax: 020 7916 8528

SBS 04/09

SBS Survey on Scottish Secondary School Science

September 2004

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Summary

This report on Scottish science education follows on from our survey of English science teachers, published in January 2004[1]. The report is based on the results of a questionnaire survey which was sent to all secondary schools in Scotland, and a subsequent discussion group with interested science teachers, held in Edinburgh.

The most significant findings are summarised here:

- 73% of teachers described the funds available for larger items of lab equipment as less than adequate.
- Around half of Scottish schools are cancelling practical lessons because they do not have the necessary equipment.
- Teachers have identified a wide range of problems with the science curriculum, with 86% expressing concern at the methods used for assessing practical skills. They felt that the design of assessments meant that students' science skills were not being developed or stretched, and even that experiments teach 'poor science'.
- Changes to departmental structuring may mean that science teachers have less opportunities for support and career progression and support.
- Scottish science teachers expect more of their mathematical colleagues than their English counterparts do. 53% say that most of the numeracy required for the science syllabus ought to be taught in maths lessons. Around half of science teachers are satisfied with the amount of mathematics they are currently teaching.
- In order to tap into teachers' expertise when making changes to the curriculum, more effective communication lines need to be put in place.
- Teachers feel that clearer and more open mechanisms are needed for the distribution of funds at Local Authority and at school level.
- Science teachers are not consistently given enough opportunity to contribute to the planning of building developments and departmental spending.
- Many of the smaller schools in Scotland are disadvantaged by the per capita funding system currently in place.

[1] Available at http://www.savebritishscience.org.uk/texts/documents/2004/SBS0401.pdf

Introduction

SBS is the independent campaign for effective science policies. We believe that science education is one of the most crucial components of the scientific health of the UK, and as such we are campaigning to improve it.

SBS regularly interacts with those working in school science education. We talk to teachers, pupils, educational suppliers, policy makers and researchers. We aim to address neglected issues, and this survey is part of a regional series of exploratory studies on subjects raised by those 'on the front line' in science education, tapping into their knowledge and experience.

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. Our initial report, restricted to English state secondary schools, focused mainly on these issues. We decided to carry out separate reports in each of the devolved administrations in order to make some comparison between systems in place. The emphasis of the current survey, of Scottish schools, has moved away from laboratory facilities, and aims to be a fair representation of the concerns of science teachers.

We expect to carry out similar surveys in Wales and Northern Ireland during the next year.

The first work to be carried out was in sending a questionnaire to the Heads of Science or Principal Teachers, in all state and private schools in Scotland, 444 in total. The questionnaire is shown in appendix one. Where stated, the results presented here are restricted to responses from state schools. We received 69 responses (a 16% response rate) by the end of March 2004. The percentage response rate was the same for both state and privately funded schools.

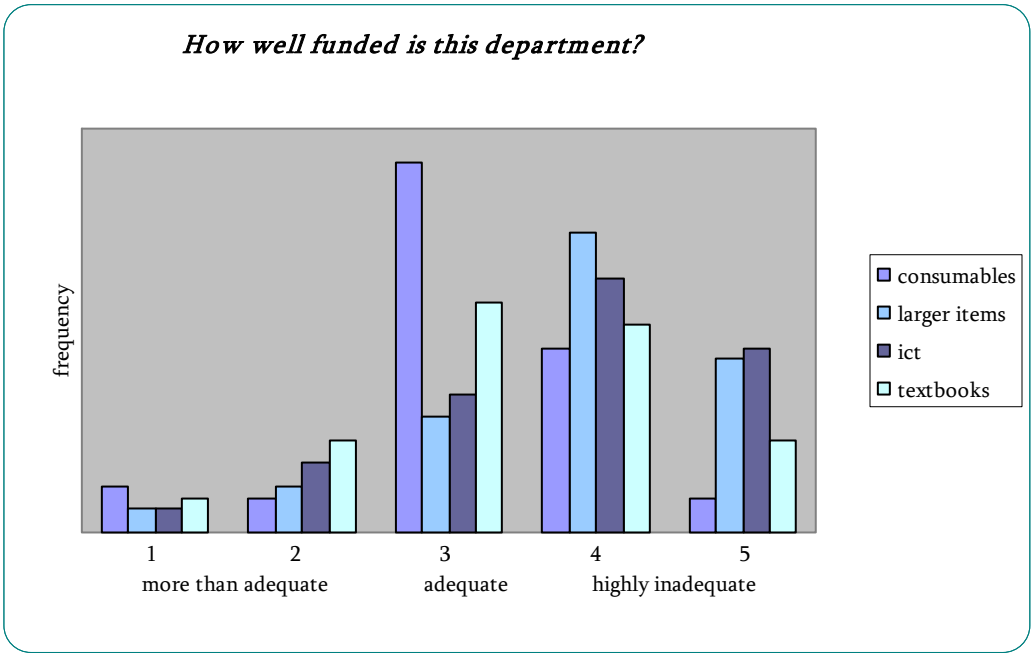
The next work we carried out was to hold a focus group with Scottish science teachers, which gave us the opportunity to investigate issues not included in the survey in a very practical way, and helped us to put the questionnaire results into context. Participants from a range of school types, including urban and rural, selective and comprehensive were invited to a day long meeting in Edinburgh.

Further data is 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

Funding Science Departments

The graph below shows how questionnaire respondents in state schools rated the adequacy of funding for different types of purchase. Teachers were asked to rate the funding in their own departments on a scale of one to five.



The results show that larger items of lab equipment are seen as worst funded, with 73% of teachers describing their budget as less than adequate. The situation for ICT is nearly as bad, with 66% of respondents describing funds as less than adequate. Textbooks are perceived as slightly better funded, with only 46% inadequate, while consumables appear to fare better, still with a third of respondents describing funds as less than adequate.[4]

Of the nineteen respondents who added comments on this subject, eight said that funds were highly variable year to year, and seven said that they had to bid for special funding for one or more of the areas of spending. It was not practical to obtain actual figures for the amounts spent in each of the categories. Many schools were unable to disclose the information, while others could not refer to a 'typical' year[5].

At our focus group, we discussed funding administration in some depth. Teachers felt that the main problems faced by school science departments arise because teachers having to continually argue their departments' case for funding, and because of miscommunication between departments, head teachers, Local Authorities and Central or Devolved Government.

[4] Again, these figures represent state funded schools only
[5] For more specific information on this issue, see Appendix 5

The bidding that takes place within many schools causes resentment between departments, takes up too much of teachers' time and does not usually arrive at the intended optimum distribution. Departments should not have to compete with each other for funding.
- At one school funds are allocated to departments on a purely per capita basis. While this could not in theory be as fair as any of the usual methods of bidding, it makes up for that in what it saves on administration time and what it gains in transparency.
- At another school, a small independent school with only one laboratory, departments were not actually allocated any budgets, but all purchase requests are made directly through the school's management body.

There is a feeling that Head teachers and local authorities have authority over some matters which would be better left to department staff; for example whether to invest in Macs or PCs. One of our questionnaire respondents commented that their entire budget '*largely depends on external funding at the whim of the Head Teacher*'.

In some areas there has been pressure from Local Authorities to invest in 'dry laboratories', i.e. computer-simulations and demonstrations of practical experiments. While this is more economical in the long run and appeals to some as a modern 'cutting edge' experience, many science teachers feel that this is not best for student learning and motivation. At the same time, ICT allocations are generally whole-school, so that to get a few computers into the laboratory for data-logging, etc. is not possible.

There is no accountability for local authorities or heads in how they choose to spend Scottish Executive Education Department (SEED) money allocated for science. In some cases there has been a substantial mismatch between the amounts departments receive and the amount allocated to their school or local authority. Head teachers have refused to let science teachers know how these funds have been spent on science.

Departments are, however, accountable to their heads and local authorities. In one case, confusion over budget codes lead to a cut in the science budget for the following year. Funds that had been spent on lab equipment were recorded as stationary, and therefore deemed unnecessary by the authority and subsequently cut.

One of the reasons why this problem may have come about may be due to mis-timing of funds. Those which are announced for September may not be distributed until the middle of the school year (e.g. March). If these funds are allocated for particular items, the items may have to be purchased initially from the per capita budget, then the loss made up with the science-specific funds later in the year. One teacher explained to us that '*stationary is used as currency in schools*'.

A questionnaire respondent commented '*government initiatives inputting to science are often ring fenced- this is a problem for us*'. At our focus group we discussed a school which had responded to a similar situation by purchasing four new video cameras, since they had already invested in two, the number they really needed, at the start of the academic year, when the local authority distributed ring-fenced funds for these items. In general, teachers feel that it is unhelpful for authorities to ring-fence funding for specific types of equipment.

There are ways that Principle Teachers can generate more income for their own departments. However, these measures can be counterproductive, since they can lead to a cut in the budget allocated by the HT from the standard, per capita funds. The schemes available also take up a lot of teachers' time and effort. One participant built up funds for his department by taking on Egyptian trainee teachers observing lessons. Equipment recycling schemes are available, but teachers must constantly 'have their ears to the ground' in order to make use of these and schools in remote areas miss out.

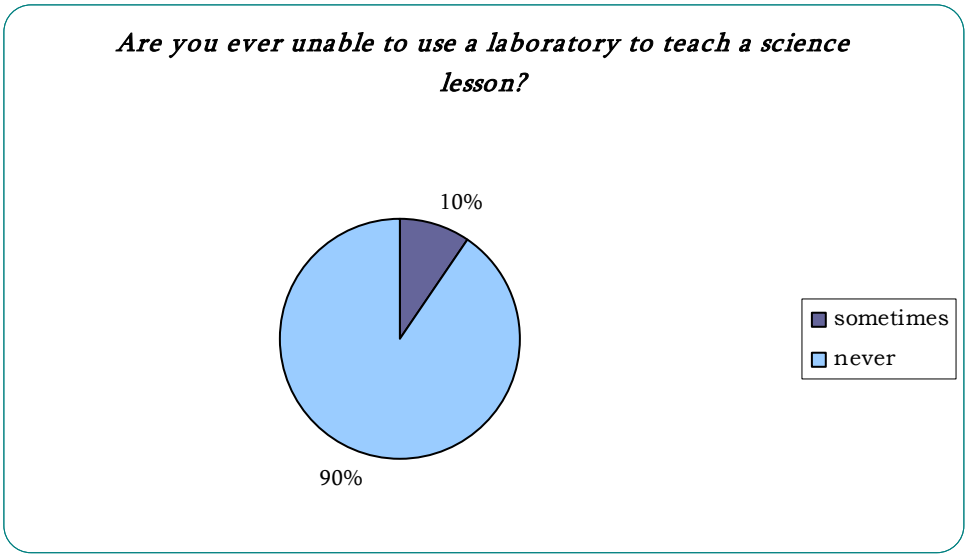
Funds are allocated to schools per capita which, particularly in practical subjects, disadvantages smaller schools. This applies both to standard allowances allocated through local authorities and to subject-specific allocations from the Scottish Executive Education Department.

Since there are a large number of small rural schools in Scotland, it would make more sense to allocate funds per laboratory. Scottish secondary schools vary in size from under 100 to around 2000 pupils, while the majority have between 400 and 1,200.[6] 25% of pupils attend schools of less than 600, and 6% attend schools of less than 500.

[6] http://www.scotland.gov.uk/library5/education/awoo.pdf *A world of opportunity; A Guide to Education and Training in Scotland*; see also Appendix 4

Practical Classes

Our survey revealed that some of the pressures on practical classes in England are not a problem in Scotland. Many English teachers told SBS that they were forced to use classrooms rather than laboratories to teach their lessons, and 68% of questionnaire respondents confirmed that this was the case. By sharp contrast, in Scottish state funded schools, only 10% are sometimes unable to use a laboratory for their lessons.



However, one Scottish teacher told us: *'We are never unable to use a laboratory to teach science lessons, but this will change in future when we lose a lab under the public private partnership scheme.'*

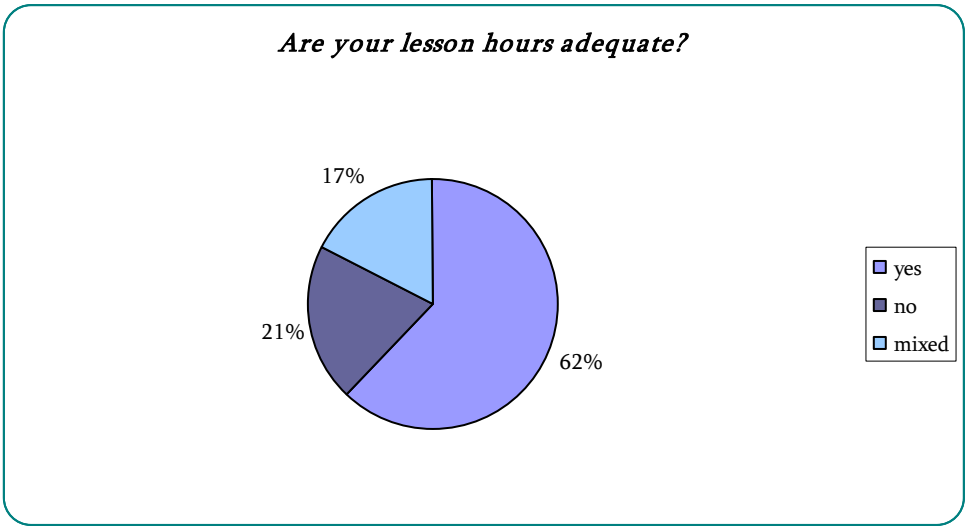
Similarly, only 8% of respondents from state schools felt that students had to carry out practicals in groups which were too large. The sharing of equipment in groups that are too large can have a negative impact in a number of ways. For example, in enabling teachers to assess the practical achievements of an individual student, or when some students are uncooperative with others, or simply because it reduces students' opportunities for learning and using practical skills.

We also asked teachers to tell us how their pupils normally carried out practical work. The table below shows the proportion of students at state schools who do practical work individually, in pairs or in larger groups.

Students working mainly:	S1	Standard Grade	Intermediate/Higher
Individually	1%	5%	4%
in pairs	70%	69%	56%
in groups of 3-5	29%	26%	40%

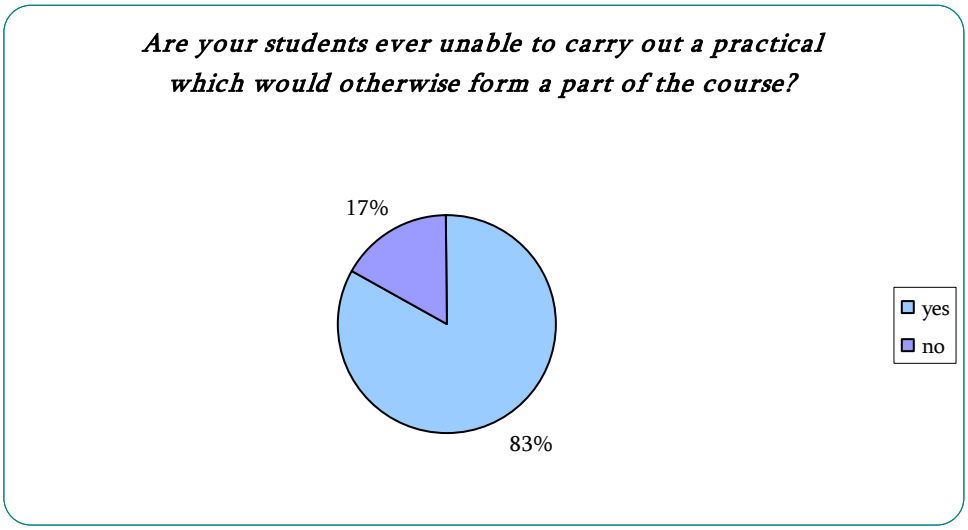
At all private schools students worked mainly in pairs, or in one case individually. Of those teachers who felt that their pupils were working in groups that were too large, most of the problems were with the senior students, sharing equipment between three or four at Higher grade. The worst situation was only occurring at one school, where pupils at all levels have to carry out experiments in groups of four or five.

We asked teachers how much time their students spend in science lessons and whether they thought this was adequate. The graph below shows the results for both state and private schools.



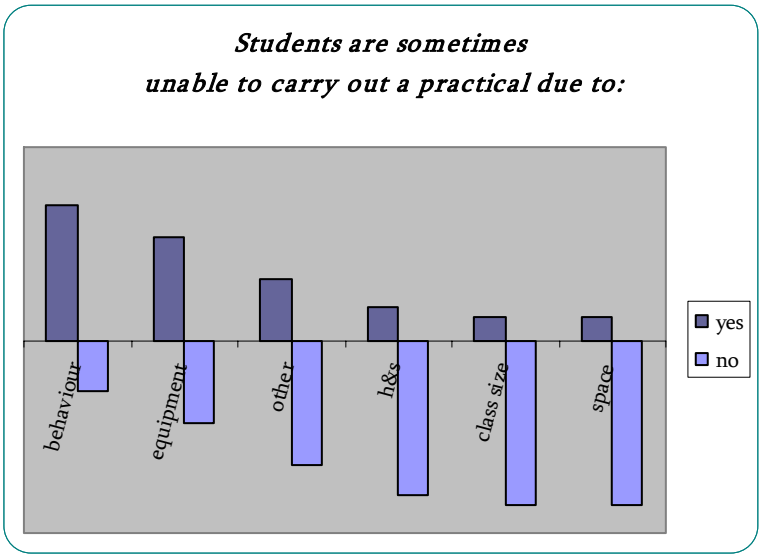
We received the following comments on the issue of lesson hours:
'[Three hours at KS3 is adequate] Given the demands from other areas of the curriculum'
'Yes to teach syllabus but little time to go outwith syllabus'
'SG [2.40] - no, not really, not time for enrichment. Higher [4.40] is really just about OK'
'4hr 24mins is not adequate for Higher, another hour would make a big difference'

Where there are more widespread problems in Scottish schools is in the cancellation of practicals. This proved to be a serious issue in England, where 77% of schools sometimes have to cancel practicals; and the situation in Scotland is, if anything, worse. We asked science teachers whether they ever had to cancel practicals because of poor student behaviour, inadequate equipment, a lack of space, class sizes, health and safety restrictions imposed by their school, or for any other reason.



In 83% of state schools students were sometimes unable to carry out practical lessons. By far the most common reason for this was student behaviour, affecting 57% of respondents, the same proportion as in England.

The graph and table below shows the frequencies of responses for each of the possible causes we listed in the questionnaire. We have categorised the issues teachers raised as 'other' reasons, and these are included in the table below.



Cause of cancellation	Proportion of schools effected
Students' Behavioural problems	57%
Lack of Equipment	51%
Lack of time (overcrowded syllabus)	14%
Health and safety concerns	11%
Lack of space	11%
class size	7%
Insufficient technician support	4%
Inadequate staff training	3%
Maintenance of facilities	3%
Restrictions on fieldwork[7]	1%

Regarding behavioural problems, the teachers at our focus group reported difficulty in trusting younger students, but were fortunate in having suitable behavioural support for their more difficult students. They saw support workers as the most suitable solution to behavioural issues.

Regarding class size, this is another area where Scottish pupils fare better than their English counterparts. In Scotland, classes for any subject with a practical element are limited to 20 pupils[8]. Scottish science teachers who spoke to SBS last year commented that this is a very helpful measure, compared to the situation in England where science lessons sometimes include more than 30 students. As some indication of the positive effect of this limit, only 10% of Scottish teachers ever had to cancel a practical due to a lack of space, compared to 31% of English teachers.

Many respondents reported cancellations for 'other' reasons. The table below shows what these reasons were:

Number of respondents	Reasons given
7	lack of time: Most of these put the cancellations down to an overcrowded curriculum, two commented that the problem is worse for senior pupils
3	lack of technician support: All of these respondents reported large numbers of cancellations
2	inadequate teacher training: In one case there were particularly bad problems for health and safety training in microbiology.
1	restrictions on fieldwork

The data collected here indicates to us how widespread the cancellation of practicals is, and what the most common reasons for it are. It is worth bearing in mind how each of these factors effect the *quality* of practical classes.

We also asked teachers to specify how many practicals they were cancelling for each of these reasons. While in some cases only three or four cancellations have been made, many schools were cancelling 20 or more lessons each year.

[7] We suspect that rather more practical work than is suggested by these responses will be prevented due to fieldwork restrictions. Since the focus of the questionnaire was on laboratory facilities, most respondents have limited their answers to this area.

[8] Provisions of the Schools Code 1956

Some teachers told us what they have to do in order to avoid cancelling more practical classes:

'Rotation of equipment enables us to cope'
'Practicals are carried out in large groups due to lack of larger items of equipment'
'Lab space for projects is a big problem, every lab is heavily used and additional small labs for projects at advanced level'
'A lack of maintenance of facilities such as gas taps mean that pupil groups have to double up'

Rebuilding and Refurbishing Projects

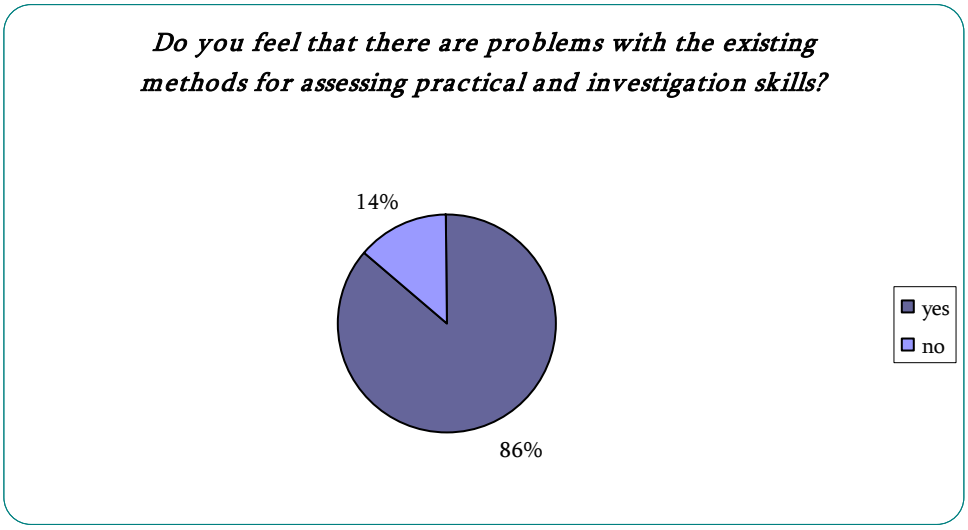
Recent rebuilding initiatives have mainly been carried out through Public-Private Partnership (PPP) schemes. Many of these have been planned independently, without teacher consultation. Head teachers are responsible for all decisions, and s/he is unlikely to have a good understanding of the requirements of science departments. Local Authorities are responsible for negotiating with the private organisations, and are not well equipped for aspects of this which require subject expertise in science. As a result, the initiatives often result in the re-housing 25 year old equipment in new rooms or buildings.

A problem with all types of rebuilding initiatives is the is a lack of architectural expertise in Scotland, and the lack of accountability for errors made in planning or budgeting. It is the science departments who pick up the cost of mistakes, even when these errors or oversights have been made by architects, Local Authorities, or other parties.

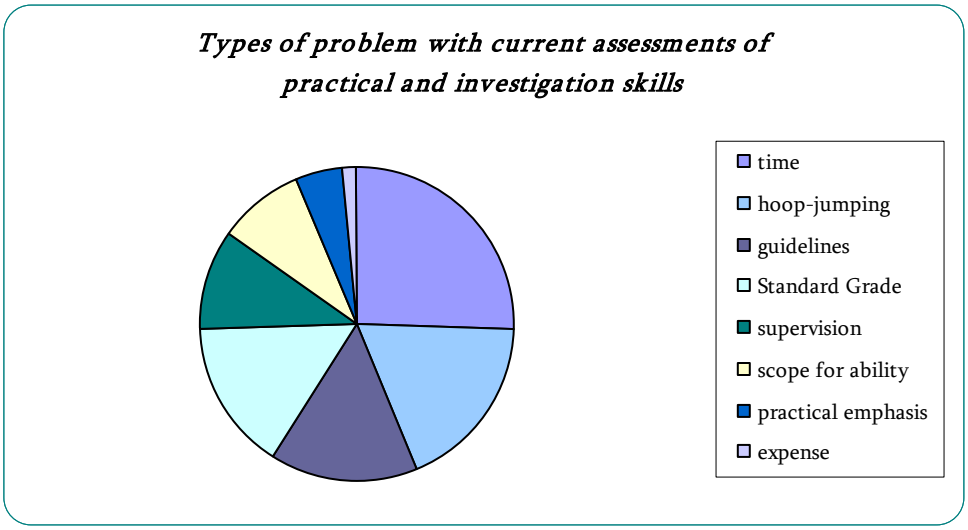
Designers can make simple mistakes which have a significant effect on practical lessons. For example, at one school paper towel dispensers were omitted; teachers now take paper towels from the school toilets for use in their classes. Teachers at our focus group recommend that there should be a standard list of requirements for school science laboratories, to be made use of by architects and planners.

Curriculum Issues

As in the English questionnaire, in our Scottish questionnaire we asked one simple question on curriculum issues, and asked for comments.



A full list of the comments we received can be found in Appendix 2. The graph below shows the spread of ideas as to the improvements needed in assessing practicals.



- The most common complaint was that the assessments are too time consuming. Some teachers felt that investigations took too much away from the time to cover other parts of the syllabus, while much of the time spent carrying out investigations has a low (scientific) educational value for pupils. Other teachers commented on the time they were required to spend remarking papers at Higher, in order to squeeze through the 100% requirement; or the time they spent in class so that their pupils could get the extra time that they needed.

- The idea that investigations have a low educational value was reiterated very clearly in the comments we received regarding 'hoop-jumping'. Teachers felt that the experiments available were dull for students, and did not represent 'good science'. Teachers also recognised the difficulties presented in resolving these problems, given the constraints on time and the need for a standardised marking scheme.

- Many respondents commented about particular problems with the Standard Grade syllabus. The investigations for this course are particularly in need of an overhaul.

- Several teachers commented that getting extra help supervising the assessed investigations would enable them to mark more fairly. Some teachers were concerned that the techniques students were required to use were too simple, limiting the learning of more talented students. Another pointed out that there is no chance to include extension work in the practical assessments. Other teachers told SBS that that the current assessments are limited in scope in that they depend so much on the academic skills of writing up, that the skills of those whose strengths lie in the practicals themselves are not fully recognised.

- A few respondents drew out this issue specifically, commenting that there is not enough emphasis on real practical skills.

- One respondent thought that practicals carried out for assessments were too expensive because each student needed their own equipment.

At our focus group, we discussed broader issues of curriculum development and the changes needed to assessment organisation.

Teachers felt that a substantial change is needed, not 'pointless tinkering here and there'. The Scottish Qualifications Authority (SQA) is perceived by Scottish teachers to be a more stable organisation than the Qualifications and Curriculum Authority (QCA) in England. However it is seen to be lacking in long term forward planning. Teachers feel that the current SQA have improved transparency, but are not in a position to drive curriculum development.

Teachers also felt that since Her Majesty's Inspectors' (HMIs') remit has changed, there has been a lack of equivalent support for teachers and no suitable communication channel between schools and national bodies such as SEED or SQA. Learning and Teaching Scotland (LTS) are not in a position to support teachers. LTS is felt to be a nonentity, lacking in leadership and subject expertise. While they offer some support with ICT materials, etc. they cannot replace the role of the HMIs because they do not visit schools and meet teachers. Teachers are hoping that the Scottish Science Advisory Committee (SSAC) will prove a suitable body to drive forward curriculum development, since they have recognised the need for more than just extra funding and are in a very good position to lobby ministers.

The teachers at our focus group felt that good quality, supportive materials were produced for the introduction of Standard Grade through consultation with teachers, HMIs, SQA and the predecessors to LTS, nation wide. By contrast, the 5-14 syllabus was developed in a 'top down' fashion, without teacher input, and the results were disappointing. Such 'top-down' curriculum developments have also tended to reduce the practical work on the syllabus. Particularly in Higher Still, there is so much subject content to cover that there is not enough time to carry out practicals; there is now only one compulsory experiment,

where there used to be 16. The proportion of the marks allocated for these components has also been greatly reduced- it was once 50%.

Syllabi are increasing in difficulty, but the teachers at our focus group felt very strongly that the curriculum should not be made easier. There is a problem of perception, in that students and their parents think that 'science is too hard'. (For candidates of generally average ability it is statistically valid that 'science is hard'; but for candidates of generally higher ability the reverse is true.) Science teachers should seek to change attitudes among students and make science accessible to all.

The gap in difficulty between standard and higher grade is too large.

Compatibility of levels: Intermediate 1 and 2 were designed to be run concurrently in a mixed ability class; however the outcome has been disappointing and most of the time this does not work. This is a particularly important factor in smaller schools, where there is no possibility of splitting classes.

Levels in general: Levels D and E don't make sense- knowledge and facts cannot be classified according to difficulty.

Alternative courses: A science for citizenship course needs to be written. SQA are unable to drive this forward since they are not allowed to promote courses.

Curriculum changes can have an impact on funding for science departments. For example,

- the introduction of Standard Grade meant a boost for laboratory equipment.
- when curricula changed in the 1980s the policy of minimum change meant there was no extra capital.
- Since there has been a reduction in the number of practical projects at Higher Still, these curriculum changes could not be used for equipment bargaining.
- Lack of core status means relative neglect at national level in terms of funding and National Priorities, and at LA level in terms of targets[9].

[9] In the early 1990s some moves were made by Michael Forsyth to give science core subject status in Scotland, but eventually Modern Languages gained the status instead. Because of this, and the poor results, funding has been put into Language departments. However, this has largely been ineffective in improving the situation, for example when funding has been spent on new carpets and students grades have fallen even lower.

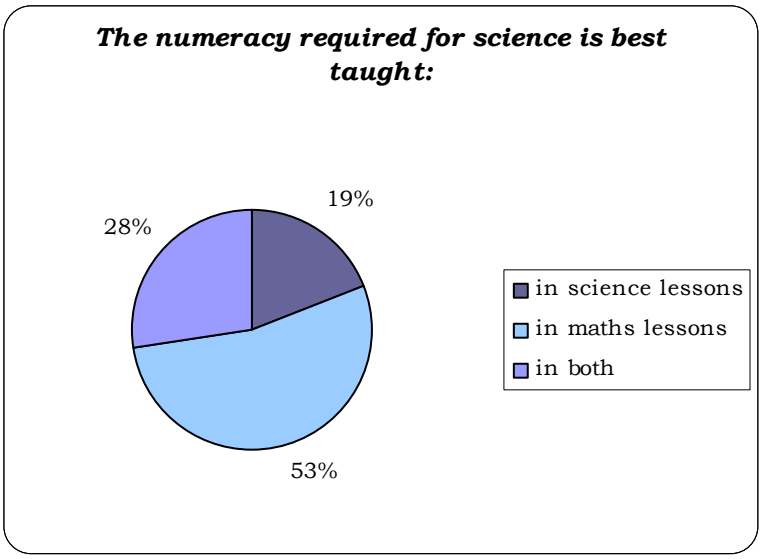
Other Issues: Materials produced by universities, companies and other institutes are often inappropriate. For example, posters printed on both sides in very small type.

Extra-curricular activities such as trips out or video conferences are hit and miss in terms of quality and syllabus-relevance. These activities cannot be included unless they match the syllabus exactly, due to alack of time. It would be useful if they could be 'vetted' by teachers on an ongoing basis.

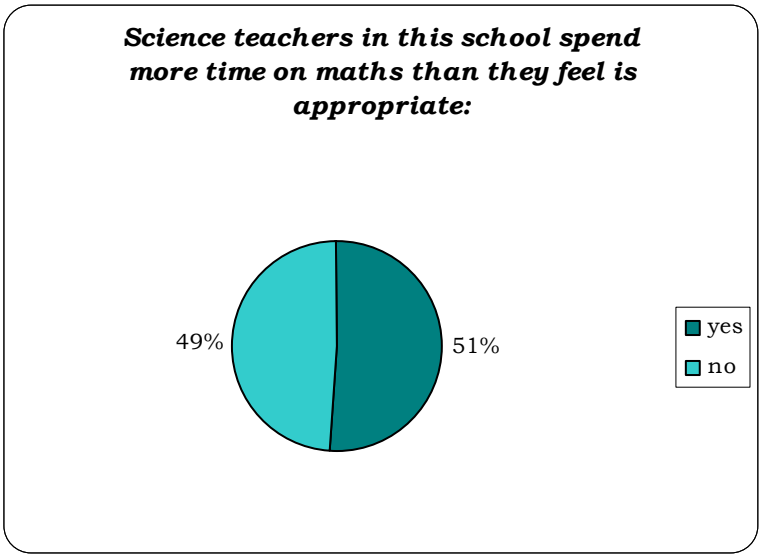
Science education and impressions received at primary level have a very important effect of students. Many primary teachers are scared of the subject or get it wrong. Children can easily be lead to view science as difficult/ out of the ordinary/ scary or intimidating, if their own teachers are not comfortable with it. Schemes to share expertise with secondary schools can have a similar effect.

Mathematics and Interdepartmental Links

A further significant curriculum- related problem for science teachers is the relation between their own lessons and those taught in mathematics lessons. We asked questionnaire respondents which department they thought should be covering the skills needed for science, and whether they thought they were currently teaching too much maths. The graphs below show our findings.



This contrasts to the views of English teachers, of whom 45% answered 'both'.



Again, this contrasts to the results of our survey in England, where only 36% of teachers feel that they are currently spending too long on mathematical skills.

At our focus group, teachers told us how surprised they were that the skills that students are lacking are so basic, for example logarithms, graph drawing or basic algebra. The problem often depends on a lack of communication or inconsistency of techniques between maths and science departments. Indeed, the comments we received from questionnaire respondents supported this, with six teachers drawing attention to the importance of coordination, communication and consistency between departments. Unfortunately, only one of these schools appeared to have a satisfactory system in place; they were using team teaching.

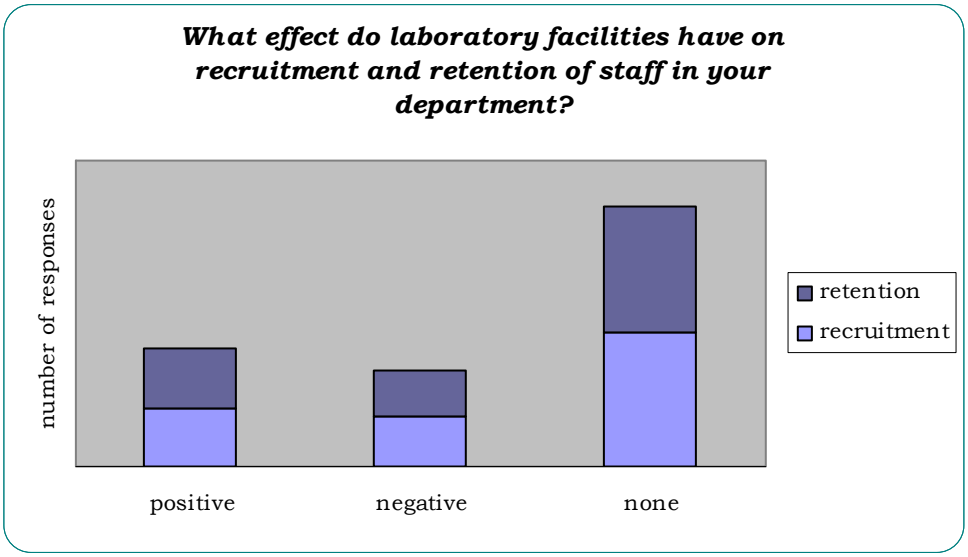
Students may also lack basic background knowledge in their English language, especially at Higher level. This presents particular difficulties in interpreting the wording of exam questions and in writing scientific essays at Higher level. Science teachers would like to see improvements in the phrasing of exam questions, to use clearer, more precise English and require less interpretation. In contrast to the situation with mathematical skills, science teachers do not see this as a fault of the relationship between their subject and others: they do not expect English departments either have this expertise or to cover skills such as scientific essay technique.

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, and although this issue is not as serious in Scotland as for the rest of the UK, it still has a significant impact, which is worsening as more teachers move into retirement.

In line with our interest in this survey in laboratory facilities, we asked our questionnaire respondents to tell us what effect the laboratories in their school have on teacher recruitment and retention. Just over half of respondents did not believe their facilities had an effect on the recruitment or retention at their school.

Effect of lab facilities	Recruitment	Retention
Positive	23%	26%
Negative	21%	20%
None	56%	54%



The lack of available teaching staff is a problem faced by all secondary schools in all subjects. For secondary science in Scotland, the lack of suitable supply teachers is particularly problematic, making it virtually impossible for teachers to take time off work for any reason. The situation is particularly bad for rural schools.[10]

Some of the issues that teachers blamed for the lack of candidates included:

- 'Thatcherism', and a desire to earn more
- a reduction in the number of science graduates [relative to other graduates/ non graduates-?]
- the many career choices available for good science students

[10] See Appendix 4

Teachers at our focus group also suggested that:

- Initial teacher Training (ITT) colleges are unable to impose adequate entry requirements, due to the lack of applicants. This is affecting the quality of science teaching.
- Mature student teachers often arrive in their first jobs with inappropriate expectations and motives.

- The school's reputation and the head teacher are major factors in recruitment for a particular school.
- Retention is not currently a problem, but with changing expectations of teachers' duties it may become one.
- Newly Qualified Teachers (NQTs) receive a lot of support, but this only lasts for one year, after which they are rather thrown in at the deep end.
- The teaching population is too old- this is very worrying.

One important issue which may impact on the science teaching workforce was raised at our focus group meeting. Teachers felt that the current plans to remove Principle Teachers and organise departments by faculty will leave individual subjects without support and leadership. Faculties will be too large, linking subjects which have little in common, and leaving teachers without the support they need within their own disciplines. It is expected that most faculty heads will be Biology PTs, since the quality is generally higher there due to relatively large supply. Teachers are concerned that this will be to the further detriment of physics and chemistry teaching. These plans will also leave less opportunity for promotion, making teaching even less attractive as a career.

Suggested reasons for students' choices of subjects include:

- the 'toys' they get
- expected grades
- parents
- senior staff
- perceptions of earning potential (this applies mainly to Highers and university choices)

Teachers suggested that it is due to inadequate careers advice that science Highers are mainly only popular among those intending to go into veterinary/medicine.

Heads and other senior staff have been known to actively discourage students of average ability from taking all three sciences at Standard Grade. Statistics show that it is harder for these students to do well in sciences. Teachers feel that such issues are exacerbated by concerns over school league tables.

While Scotland needs more and better scientist role models, ambassador schemes can be problematic. Teachers may not have enough time to organise the schemes, and participants may arrive without appropriate communications skills or without a clear understanding of the stage students are at.

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 hours of science lessons do students receive each week during:

KS3? _____

Standard Grade? _____

Intermediate/ Higher? _____

2. Do you feel these hours are adequate?

Yes / No

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

	KS3	Standard	Higher
Never	☐	☐	☐
Less than 10% of lessons	☐	☐	☐
10-20% of lessons	☐	☐	☐
20-30% of lessons	☐	☐	☐
Other (please specify)	_____	_____	_____

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

	KS3	Standard	Higher
individually?	☐	☐	☐
in pairs?	☐	☐	☐
in groups of three?	☐	☐	☐
in groups of four?	☐	☐	☐
in larger groups?	☐	☐	☐

Do you feel these groups are too large?

Yes/No

5. How many laboratories are there in your school?

_____

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

Yes/ No

Please comment:_____

_____

_____

7. Roughly how many times each year are your students unable to carry out a practical which would otherwise form a part of the course, due to:

	times per year
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. How well funded do you feel your department is for:

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

9. If you are willing to provide this information, could you tell us roughly how much is spent annually on each of these?

	£
consumable supplies	_____
larger items of lab equipment	_____
ICT equipment	_____
Textbooks	_____

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
Responses received for Question 6

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

I feel that a 'full' investigation does not enable pupils to show their ability if their experiment is poorly planned or didn't work properly especially in concluding. Prformas on how to assess 5-14 skills in a MANAGABLE way in a lab with 20 pupils to one teacher is required. If this is not possible the skills elements at 5-14 should be modified so they are accessible.
Too time consuming in content heavy syllabi.
The Standard Grade investigation booklet needs updating.
Very worthwhile- but teachers spend too long giving students extra time
Too time consuming and little worth
Extremely time consuming for little gain in pupil learning. Very costly in terms of resources as are done individually.
Not standardised over whole of Scotland.
Practical skills assessment takes up too much time- particularly for reassessment process which invariably involves the less able who need more time for theory anyway.
Methods are too formulaic; time consuming for teacher; the way they are set up gives little educational benefit.
[Investigation skills ok, but assessment of practical skills more difficult- no national structure to coordinate/ good guidelines on coherent assessment.
Not enough help manpower wise.
Difficult to assess a pupil's own work when he/she can observe others doing similar work. Difficult to watch practical work when around 5 pupils are being assessed while the remainder of the class (usually up to 15 pupils) are doing written work and may need assistance.
In Standard Grade Practical Abilities assessment is too much like following a set of instructions In Intermediate and Higher it has been pruned back to just one, irrelevant, practical and write up.
Waste of time.
Have become too formulaic due to pressure of time to effectively analyse and mark them.
Investigations at Standard Grade is a 'hoop-jumping' exercise.
Pupils must get 100% correct at Higher grade to pass- leads to many remarked scripts.
They are too time consuming for the value. We would rather do more and assess less.
The process is artificial and pressurised by time constraints.
There are problems at S Grade: investigations are dull and repetitive. Advanced Higher: excellent compromise.
They don't really test practical skills
S Grade: format too prescriptive, techniques too simple. H and AH: assessed only on report writing.
At Standard Grade, despite national central modernisation, different schools employ different methods of organisation and so some students have an easier task than others. Too little practical work is done and assessed.
Time to make it a worthwhile exercise Courses too full of other materials to be covered.
The existing assessments do not teach true practical skills and definitely not true investigative skills. They teach pupils to complete artificial assessments because these are the only assessments that can be marked objectively with the least amount of subjectivity. However we are convinced that despite best efforts by the SQA there is a wide variation in standards of assessment across schools.
YES. The internal exam is meaningless as schools correct pupils' work before --- for moderation. Should be externally assessed.
Assessments take too long to complete.
Redrafting means most get full marks sometimes group work needed due to lack of resources or it takes too

long a time to go through everyone individually.
At standard grade format is too repetitive and restrictive.
It does not really assess skills but ensures that skills are taught. Emphasis on skills for exam purposes only.
Pupils are unclear about the requirements which I feel should be on the booklet. I.e. requirements for gaining points in practical assessments should be clearer. In S1/S2 there needs to be more examples to use in teaching and carrying out investigations in science.
Very artificial and contrived.
Marking of investigations onerous and tedious (standard grade)
Difficult to observe whole class when completing investigations. Practical techniques are simple, but time consuming. Pupil absence and 'catch up' are difficult.
Standard Grade: far too much in time available.
Too prescriptive. Too simple- just hoops for pupils to jump through. No valid educational reason for present setup.
Too prescriptive (especially at S Grade). Takes the enjoyment out of practical work. Pupils only worrying about gaining the mark not particularly on what they are doing and why. Virtually all skills can be assessed during a written exam.
Assessment materials are unwieldy, not valid for assessing skills. Too much teacher work for little or no useful info/data.
To do it properly is time consuming and takes no account of absences etc.
Too time consuming
Far too open to teacher assistance
Some more investigations structured for S1/2 level needed but generally ok
In a practical class of 20 it is difficult to monitor pupils. Also, a lot of experiments are poor science.
Most are heavily dependent on academic ability
Too often [?] and 'false' as a method of grading pupils.
20 separate investigations all at the same time only one teacher. No real developments of thought for real investigations, time constraints and specific nature of marking allows no scope for extension work.
Grading is difficult. Supervision is difficult because pupils need individual attention.
At Standard Grade the assessment isn't always related to the course and most pupils gain a Grade 1. The investigations are not novel and do not extend the pupils.
Paired teaching required. Insufficient space for half class to do practical whilst other half does written work.
---- of 'case' how good is it!!
These consume too much teaching time
SG depends on ability to write up in booklet not [ability to] do the practical skilfully.
Insufficient guidelines from 5-14 as to how to carry out assessment – we have devised a system but assessment is very time consuming and unclear e.g. a student can achieve level F for planning tasks, E for carrying out tasks and D for reviewing/reporting tasks – so what level is given for skills overall? D –F? Or several grades (?) as well as their knowledge and understanding grade?
Time taken by some pupils to complete an investigation. Their reports will be good if they are good in written communication. If not, it is often difficult to interpret what they mean.

Appendix 3
Responses on Mathematics and Numeracy

Both if it is taught the same way.
More cooperation is required; maths syllabuses should reflect demands required to access other curricular areas.
Basic maths skills would help.
Children are lacking in numeracy skills and this has a negative effect in the sciences.
(science) but we need to know how things are done in maths
The mathematical techniques should be taught in maths and reinforced in science
Taught in maths but reinforced in science
Q9- more maths: it is an issue but not major. More liaison between departments would help consistency but covering skills in both departments is useful.
It is taught in maths but pupils don't transfer it to science
Maths should teach basics in form suited to science. Science must show applications.
Both cross curricular links useful for reinforcing skills you are trying to teach.
Q9: sometimes!! We have good links with the maths dept. Q10: Team teaching with sci/maths teachers. Learning support can also help (esp in S3/4 science)
Both, but it is better if it has been taught in a maths class too!!
Mixture and reinforce
A bit of both but need to be consistent in methodology
This should be approached as a cross curricular opportunity that ultimately would solve problems in numeracy for both maths and science.

Appendix 4
Data on school sizes and supply teachers

The table below is extracted from *A world of opportunity; A Guide to Education and Training in Scotland*[11] and shows 2003 data for school sizes of all secondary schools in Scotland:

Number of pupils per school	Number of schools in this bracket	Total number of pupils in this bracket
under 50	13	370
50-99	9	673
100-199	10	1,495
200-299	7	1,743
300-399	12	4,300
400-499	20	9,086
500-599	28	15,344
600-799	67	47,374
800-999	95	84,751
1,000-1,199	66	71,836
1,200 and over	59	81,455

The following table is extracted from Statistical Publication Edn/G5/2004/2 Teachers in Scotland, 2003, and shows supply teachers in secondary schools during census week:

	Total
Mathematics	23
Biology	22
Chemistry	7
General Science	4
Physics	6

[11] http://www.scotland.gov.uk/library5/education/awoo.pdf

Appendix 5
Data on Expenditure

The following table is an extract from Stuart Farmer's *Decisions about Funding Allocations: An Analysis of the Resourcing of Physics Departments in Scottish Secondary Schools*, MBA dissertation, University of Leicester.

'Table 2: Comparison of mean physics department budgets in 2001 and 2003.

	2001, £ (n = 66)	2003, £ (n = 66)
mean physics budget allocation	4947	4636
mean budget per physics laboratory	1530	1434
mean physics budget per pupil on school roll	5·75	5·38

As can be seen from Table 2 the mean budget for the physics departments in these schools has decreased by £311 over the two year period 2001 to 2003. This represents a budget cut of 6% and does not take inflation into account. Assuming an inflation rate of 3%[12] over these two years, this increases the mean budget cut to 12%.'

To put this extract into context, the *Statistics Publication Notice Expenditure on School Education in Scotland, 2003*[13] includes the following figures for budgeted running costs in all state funded secondary schools:

	National total, £000	Spend per pupil, £
2000-01	975,074	3,098
2001-02	1,048,766	3,311
2002-03	1,109,351	3,513
2003-04	1,195,312	3,770

Further extracts from Stuart Farmer's research include:

Spending category	state (n = 58)	independent (n = 8)
Equipment - physics	36%	64%
Equipment - ICT	12%	10%
Photocopying, textbooks & stationery	54%	26%

Who is involved in making budget allocation decisions	Percentage
Headteacher only	44%
Headteacher and member(s) of SMT	33%
Finance Committee	20%
Unsure	3%

[12] During the period 2001 to 2003 the inflation rate in the UK although variable has remained close to 3%.
[13] http://www.scotland.gov.uk/stats/bulletins/00303-08.asp