The Learned Societies' Group on Scottish Science Education

Resourcing School Science in Scotland:

An Indicative Study of Primary and Secondary Schools

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1. Introduction

1.1 Background to the Study

Over ten years have passed since data were gathered across Scotland about the funding, supply and maintenance of science practical equipment in Scottish schools. Based on funding data collected between 2001 and 2003, it was determined that secondary school physics departments received, on average, 16.5% of the funding required for replacing, maintaining and updating equipment, based on the Scottish Schools Education Research Centre (SSERC) cost estimates. It was also found that physics departments spent 50% of their budget on photocopying and other non-equipment costs[1].

In its January 2012 report *Supporting Scotland's STEM education and culture*, the Science and Engineering Education Advisory Group (SEEAG) pointed out that the tightening of school budgets in recent times would inevitably put even greater pressure on the funding available to science departments to spend on equipment[2].

SEEAG's report went on to recommend that SSERC should build on its previous work and that of The Royal Society, London to research the cost of adequately delivering the STEM curriculum at all stages in Scottish schools. Moreover, it recommended that schools must be provided with adequate funds to provide and maintain sufficient equipment for effective hands-on experiences[3].

The Learned Societies' Group on Scottish Science Education (LSG) was formally launched in May 2012. Its remit includes identifying and promoting priorities for school science education in Scotland; monitoring and responding to school science education initiatives and developments; and stimulating debate relating to these issues in Scotland[4]. The group comprises representatives from a number of professional institutes and learned societies with an active interest in STEM education. In addition, it has established a connection with STEMEC, an independent advisory group which has been formed to take forward work arising from SEEAG's report.

A further impetus to gather up-to-date intelligence in Scotland has been Pye Tait Consulting's 2013 research for Science Community Representing Education (SCORE) on the resourcing of practical science equipment in primary and secondary schools in England. The research highlighted an acute shortage in schools and sixth form colleges of essential equipment and consumables for practical work in science. There were concerns the situation may be similar in Scotland.

[1] Science and Engineering Education Advisory Group (2012) *Supporting Scotland's STEM education and culture.*
[2] Ibid.
[3] Ibid.
[4] Learned Societies' Group on Scottish Science Education (2012) *Summary of launch event.*

1.2 Research Aims

The aim of the research was to obtain indicative evidence relating to the state of funding and practical equipment resourcing for delivery of the science curriculum within schools in Scotland.

This evidence provides a basis for the LSG to prioritise and formulate responses to key emerging issues for the benefit of schools in Scotland.

1.3 Methodology

As at 1st April 2013 there were 2,060 state maintained primary schools and 365 state maintained secondary schools in Scotland[5]. With respect to this population, the LSG commissioned an online survey to gather indicative evidence from a maximum of 50 primary and 50 secondary schools.

Two separate questionnaires were developed and tailored for primary and secondary schools respectively. The online survey was then developed and hosted by Pye Tait Consulting between 6th March and 26th June 2014.

A sample of schools was identified by the LSG and partners to be invited to participate. An initial survey invitation email was sent out to each of these schools by Pye Tait Consulting and followed up by two reminder emails. The LSG also helped to promote the survey via email communications and through partners.

To avoid the risk of double-counting, the survey required only one response per school, with the suggestion that a single contact point took responsibility for collating information from colleagues, where appropriate.

For primary schools the survey was addressed to the Head Teacher or Science Coordinator (or equivalent role, as applicable). In secondary schools the survey was addressed to the Head of Science (or equivalent role).

1.4 Achieved Sample and Margins of Error

The total number of survey responses is shown in Table 1. The margins of error – as would be expected with such small samples - are high and are likely to be higher for questions that were not answered by all respondents. As such the findings should be treated with caution and purely as an indication of the Scotland-wide picture.

For this reason, all decimal points have been rounded.

[5] Scottish Government (2013) *High level summary of statistics – school education.*

Table 1 Total responses and margins of error

Type of school	Total responses	Confidence level	Margin of error
Primary	39	95%	15%
Secondary	46	95%	14%

Please note that due to the effect of rounding, certain percentages within this report may not add up to precisely 100%.

1.5 Profile of Surveyed Schools

The survey achieved responses from schools of various sizes, as shown in Table 2.

Table 2 Size of surveyed schools

Type of school	Average number of pupils	Minimum recorded	Maximum recorded
Primary	213	27	705
Secondary	780	48	1,700

Science in secondary schools

Secondary school education in Scotland begins at age 11 to 12 (year S1) and extends to age 17 to 18 (year S6).

- In years S1 and S2, science education is not usually disaggregated into discrete subject areas;
- In years S3 and S4, 'science' is offered as a separate subject area in addition to the discrete subjects of biology, chemistry and physics;
- In years S5 and S6 'science' is not offered as a separate subject area in addition to biology, chemistry and physics;

Among surveyed secondary schools, the average number of pupils recorded across each year group is shown in Table 3. For years S3 to S6, pupils are counted more than once where they study multiple science subjects.

Table 3 Total number of pupils by year (Secondary schools)

Year	Subject	Number of pupils
S1	**All**	**138**
S2	**All**	**139**
S3	**All**	**139**
	Science	37
	Biology	79
	Chemistry	72
	Physics	61
	Other Sciences	2
S4	**All**	**141**
	Science	7
	Biology	66
	Chemistry	55
	Physics	48
	Other Sciences	2
S5	**All**	**115**
	Biology	47
	Chemistry	31
	Physics	31
	Other Sciences	4
S6	**All**	**79**
	Biology	13
	Chemistry	12
	Physics	9
	Other Sciences	3

All 46 surveyed secondary schools reported offering National 4/5 qualifications in the sciences. Of these:

- 45 also offer Highers; and
- 44 also offer Advanced Highers.

Other qualifications reportedly offered in science:

- Science Baccalaureate (4 respondents)
- National 3 (3 respondents)
- Intermediate 1 and Intermediate 2 (2 respondents)

Membership of other organisations

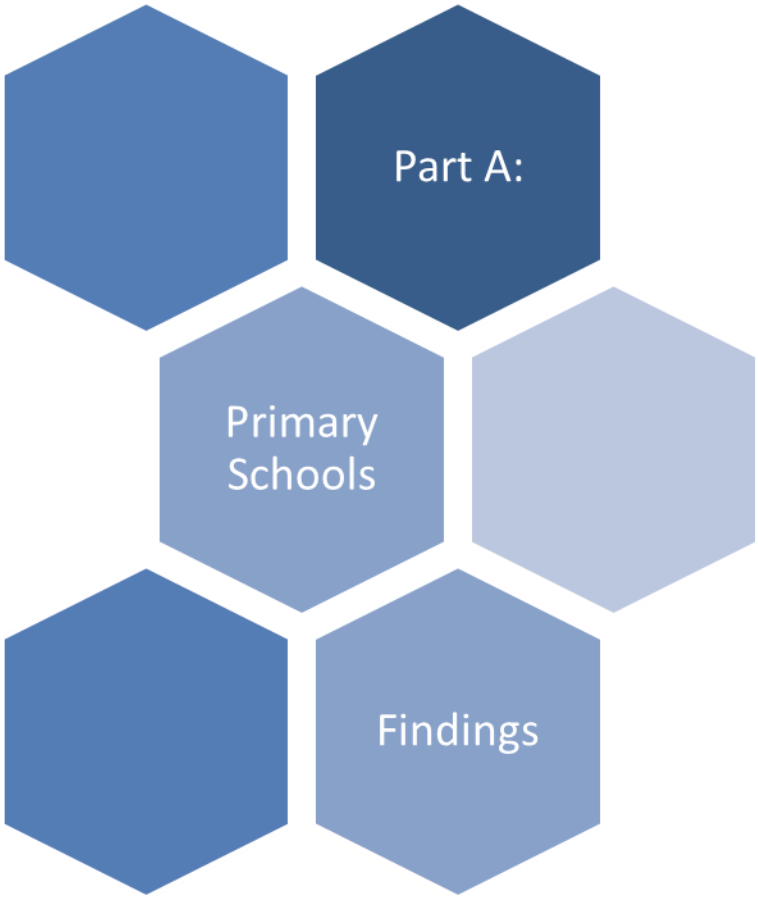
Three quarters (74%) of secondary schools confirmed that either the school or individual teachers are members of at least one science professional body, compared with just 10% primary schools.

Organisations of which primary schools report being members:

- STEM Ambassadors (2 schools);
- Young Engineers and Science Clubs Scotland (2 schools);
- British Science Association (1 school);
- Dundee Science Centre (1 school); and
- Society of Microbiology (1 school).

Organisations of which secondary schools report being members:

- Institute of Physics (IOP) (24 schools);
- Royal Society of Chemistry (RSC) (21 schools);
- Association for Science Education (ASE) (14 schools);
- Society of Biology (SOB) (6 schools);
- Society for General Microbiology (SGM) (3 schools); and
- Royal Society of Microbiology (1 school).


Part A:
Primary Schools
Findings

2. Primary Schools – Findings

2.1 Funding for Science

Among surveyed primary schools, the average spend on science has increased from £280 (2012-13) to £343 (2013-14) representing a rise of 21%. The total spend on practical work accounts for just under two thirds (62%) of total science spend (Table 4).

The average spend on science per capita has increased from £1.33 (2012-13) to £1.62 (2013-14). The lowest recorded per capita spend in 2013-14 is £0.00 and the highest is £17.14.

Table 4 School Science Spend

Year[6]	Average school spend on science	Average school spend on science per capita	Average school spend on science practical work	Spend on science practical work as a % of total science spend
2013-14	£343	£1.62	£214	62%
2012-13	£280	£1.33	(Not recorded)	N/A

Base: 37 Respondents

NB: 10 schools stated that science spend was nil in one or both years.

Over the course of the next year, the level of spend on science is estimated to grow by an average of 12.9% among surveyed schools.

Of the 38 schools that provided an estimated change percentage:

- A quarter (12) expect an increase (ranging from 5% to 200%);
- Just over half (22) expect science spend to remain at the same level as the current year; and
- A small minority (4) expect a decrease (ranging from 10% to 50%).

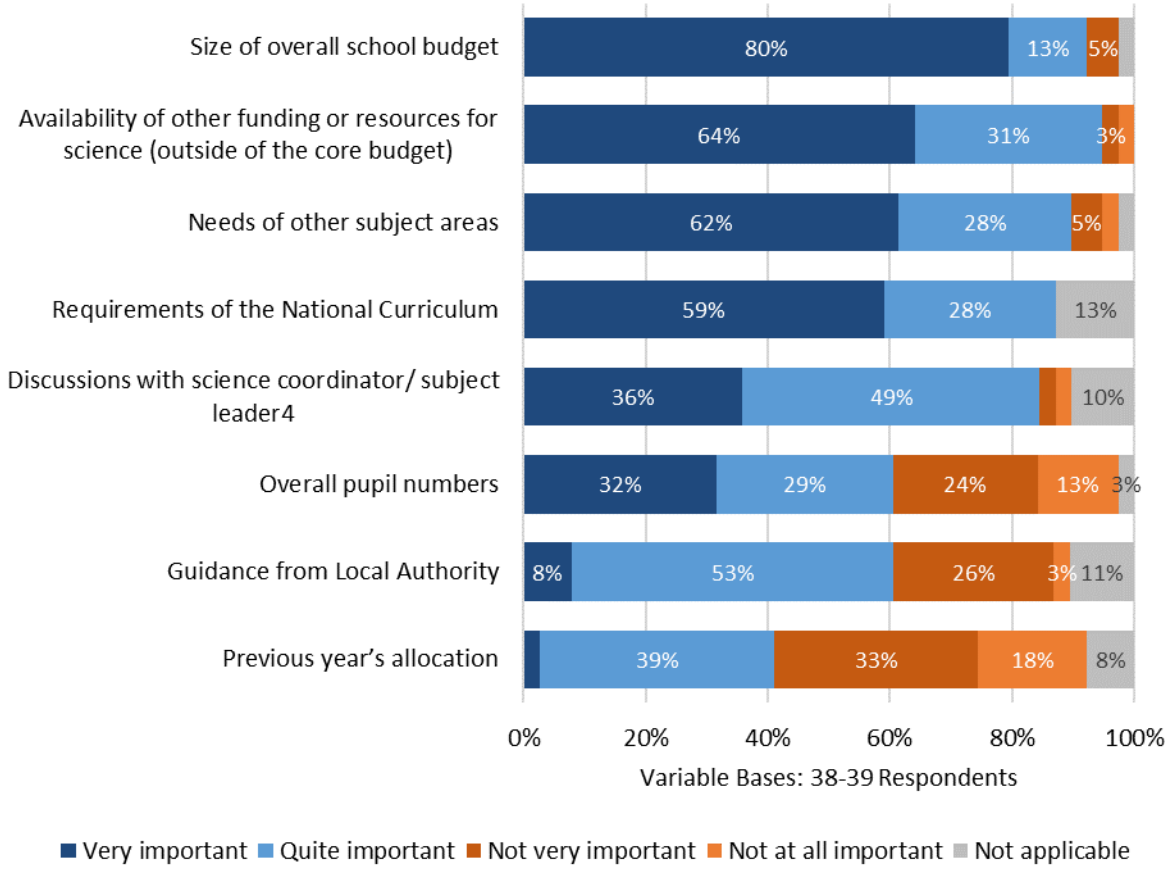
It should be noted that percentage changes may represent relatively small amounts in monetary terms.

Schools were asked to rate the importance of various factors when deciding how much funding to allocate to science. The most important of these are:

[6] Schools used their discretion as to whether they defined the year bands as financial year or academic year.

- Size of the overall school budget;
- Availability of other funding or resources for science (outside of the core budget); and
- Needs of other subject areas (Figure 1).

Figure 1 Importance of factors when allocating funding available for science



Other factors that have been important to primary schools when allocating funding for science:

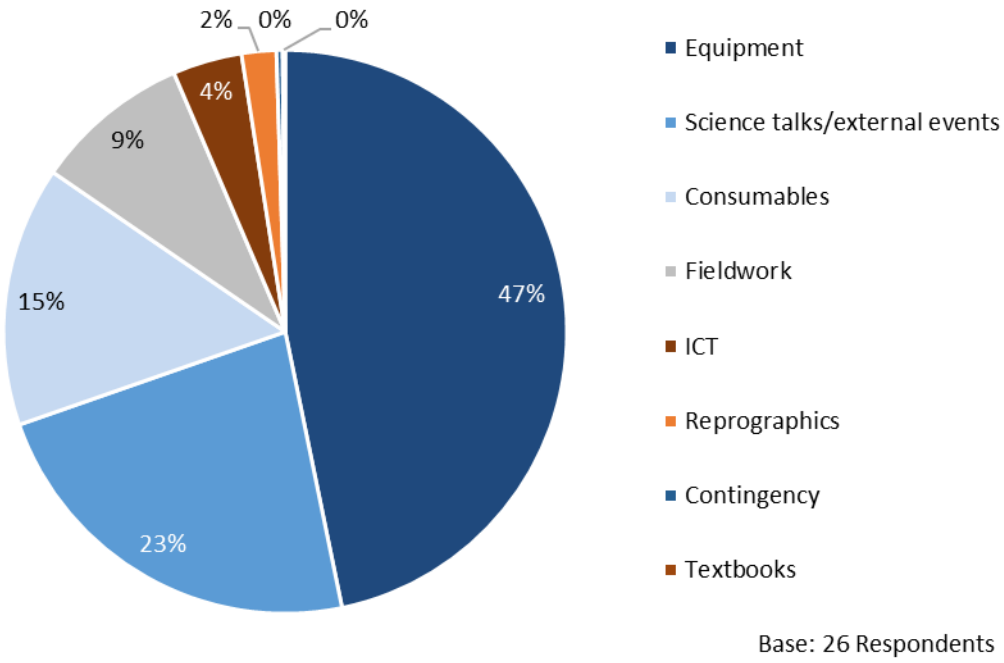
- Current funding priorities (3 respondents) including those defined in the School Improvement Plan (2 respondents);
- Cluster budgets being allocated to a science working group (1 respondent);
- Amount of funding available from the Parent Teacher Association (1 respondent);
- Having made use of Enthuse awards and EDINA grants to fund science training for staff and

resources to be held centrally in the learning community (1 respondent); and

- A total of £6,000 being spent over the last 2 years due to being finalists in the Rolls Royce Science Prize (1 respondent).

Primary schools were asked to specify how the science budget is allocated across a number of distinct areas. The findings reveal that, on average, exactly half the budget is allocated to equipment, with the remainder spread across other areas including science talks/external events and consumables (Figure 2). Some 33% of schools were unable to answer this question, with most stating that they did not hold or record information and breakdowns of science spend in this way.

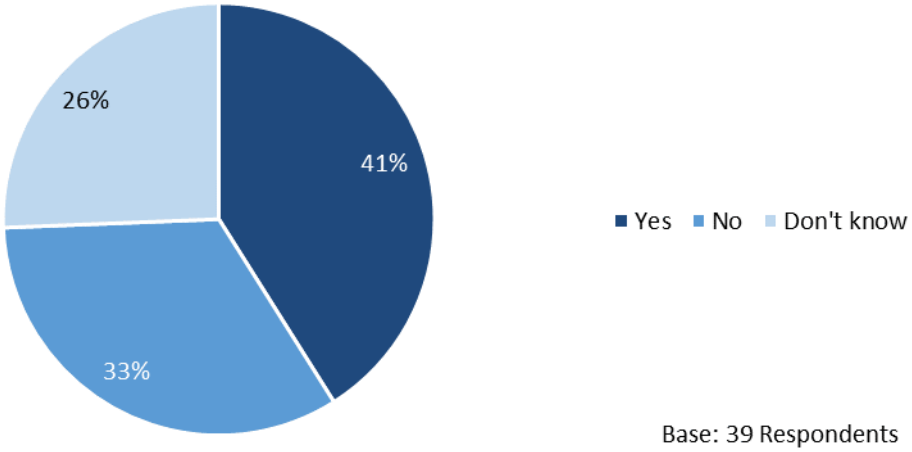
Figure 2 Allocation of the science budget across all year groups



Base: 26 Respondents

Just under half (41%) of primary schools confirmed that they are required to spend their science budget within the full year and that monies cannot be rolled on to the following year (Figure 3).

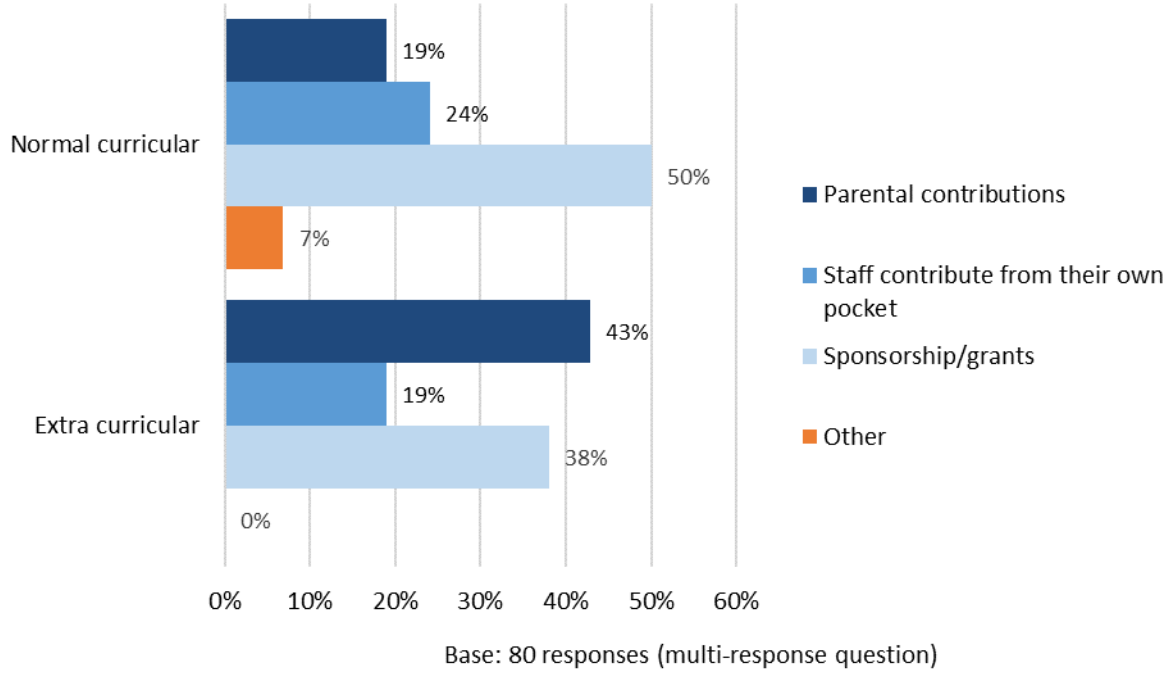
Figure 3 Whether the science budget must be spent in the current year



2.2 Funding for Science Practical Work

All but one primary school (98%) reported using at least one additional source of funding to support science practical work. Sponsorship grants are the most popular additional source within a normal curricular setting, while parental contributions are the most common additional source for extra-curricular activities (Figure 4).

Figure 4 Additional sources of funding for science practical work

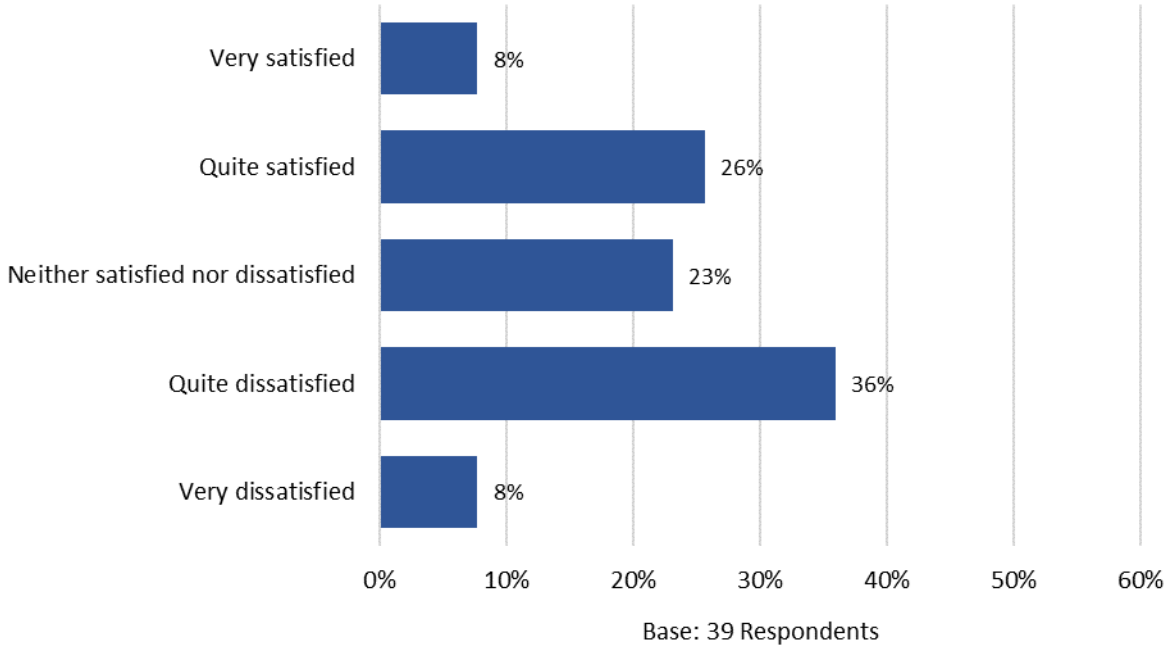


Sources of additional funding listed as 'other' include:

- Cluster funding;
- Equipment gifted from external organisations;
- Grants for staff training and resources;
- Local authority;
- PTA Funding; and
- SCDI Young Engineers Club.

Just over a third of primary schools (34%) are satisifed that they have sufficient funding available for science practical work (Figure 5) with 44% being either very or quite dissatisfied.

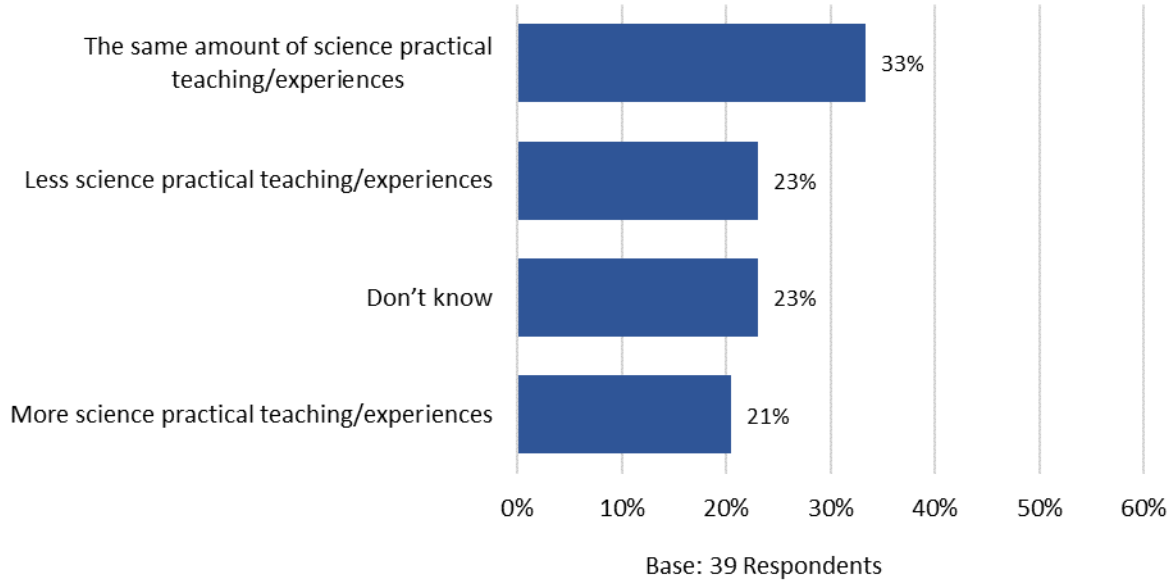
Figure 5 Satisfaction with funding for science practical work



There are mixed expectations regarding how funding levels over the next two years are likely to affect the amount of science practical teaching and experiences offered to pupils.

Approximately one third (33%) of primary schools believe the amount of practical teaching will remain the same, while a just under a quarter (23%) believe it will decrease (Figure 6).

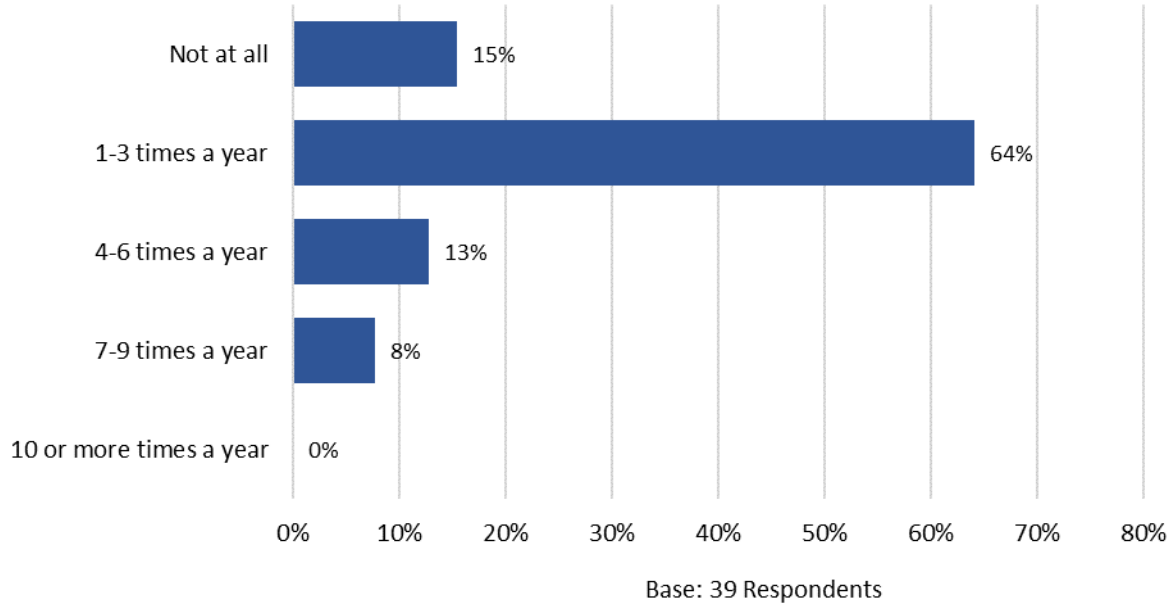
Figure 6 How future funding levels may affect the amount of science practical teaching



2.3 Teaching Support

The majority (85%) of surveyed primary schools have help from people outside the school to deliver practical science demonstrations. The frequency of this varies, with just under two thirds (63%) reporting that people come in between one and three times per year (Figure 7).

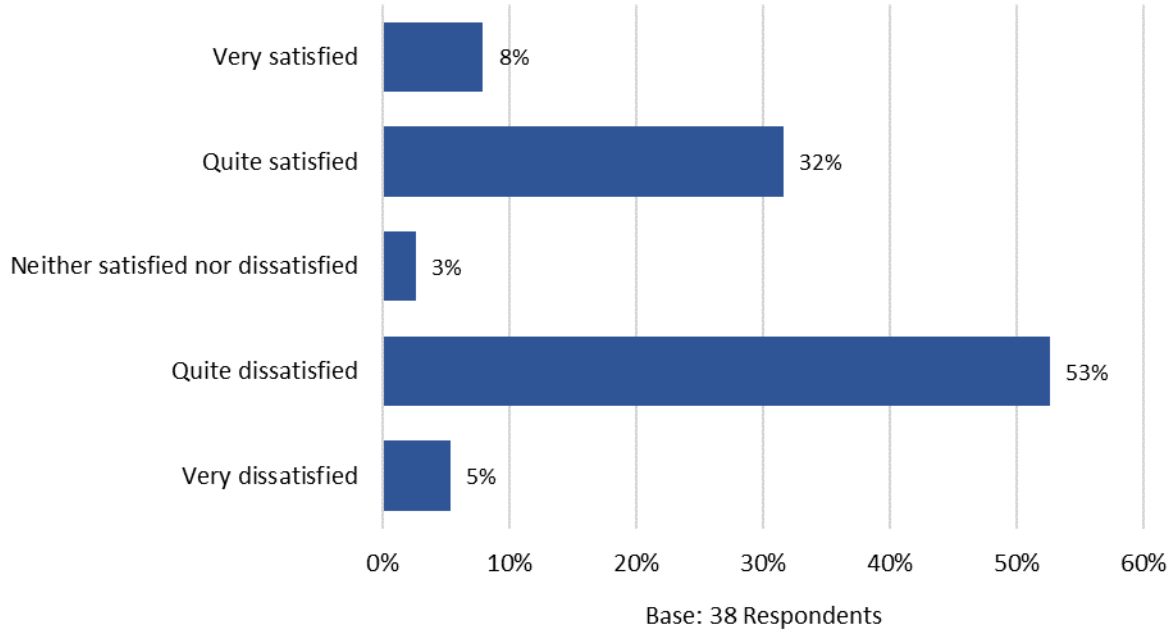
Figure 7 How often people from outside the school help with science demonstrations



2.4 Science Equipment and Consumables

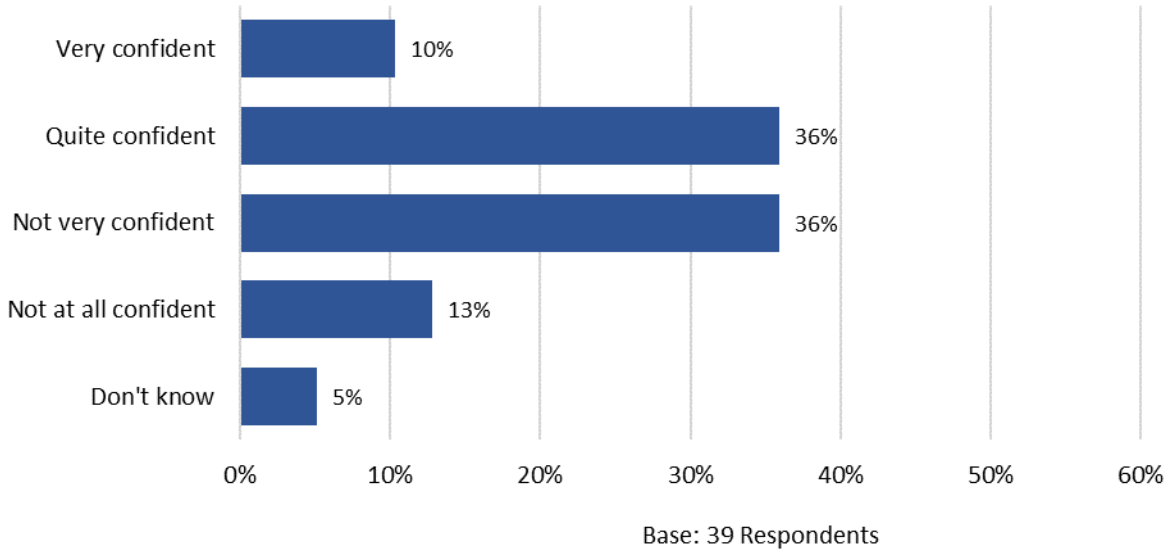
Just over half (58%) of primary schools believe they do not have sufficient equipment and consumables to deliver science practical work effectively (Figure 8).

Figure 8 Satisfaction with current amount of science equipment and consumables



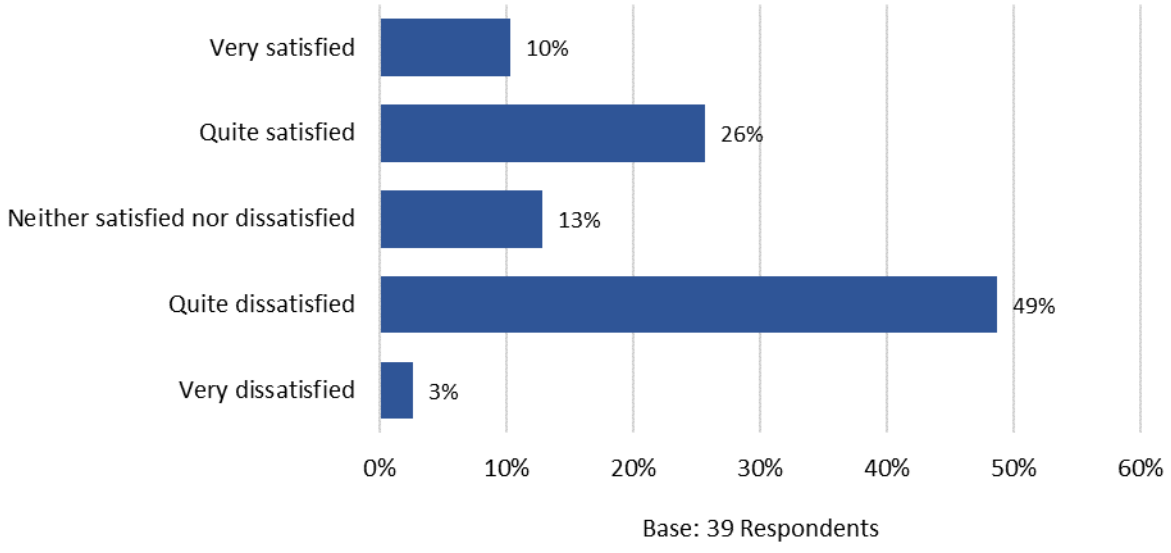
Views are divided in terms of schools' confidence in having enough equipment and consumables over the next two academic years to deliver science practical work effectively. While 46% are generally confident, 49% are not confident and a further 5% don't know (Figure 9).

Figure 9 Confidence in having enough science equipment over the next two years



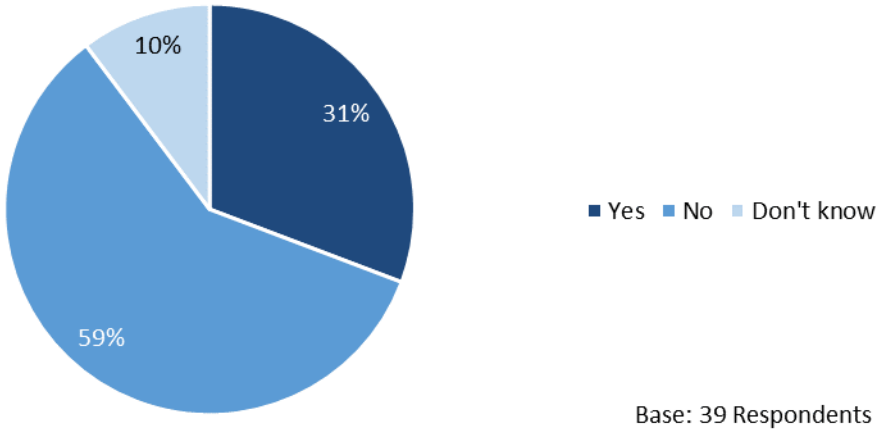
Just over half of primary schools (52%) feel they do not have sufficient access to training on the use of science equipment and consumables (Figure 10).

Figure 10 Satisfaction with access to training on science equipment and consumables



Most primary schools (59%) confirmed that they are not free to choose which supplier of science equipment and consumables offer the best value for money (Figure 11).

Figure 11 Whether free to choose the supplier of science equipment and consumables



Base: 39 Respondents

Schools were asked to indicate their ability to access a range of specific equipment and consumables for practical science delivery.

For each item schools were asked to select whether they:

- Have enough in working order;
- Have enough but not all working;
- Don't have enough;
- Have but don't need;
- Don't have but need; or
- Don't have but don't need.

The full results are presented in Figures 12 and 13.The main points are as follows:

- For each listed item of equipment, less than half of primary schools report having enough and all in working order;

- There are relatively few instances of schools having sufficient supply of items but not in working order (although notable exceptions are stopwatches, buzzers and motors);

- The main problem appears to be that schools have insufficient supply of equipment they currently use (particularly torches, magnets and magnifiers); and

- Among items of equipment that schools need but don't have at all– the most widely sought after items include equipment to measure lung capacity, access to a skeleton and graded sieves.

Figure 12 Access to science equipment and consumables (part 1)

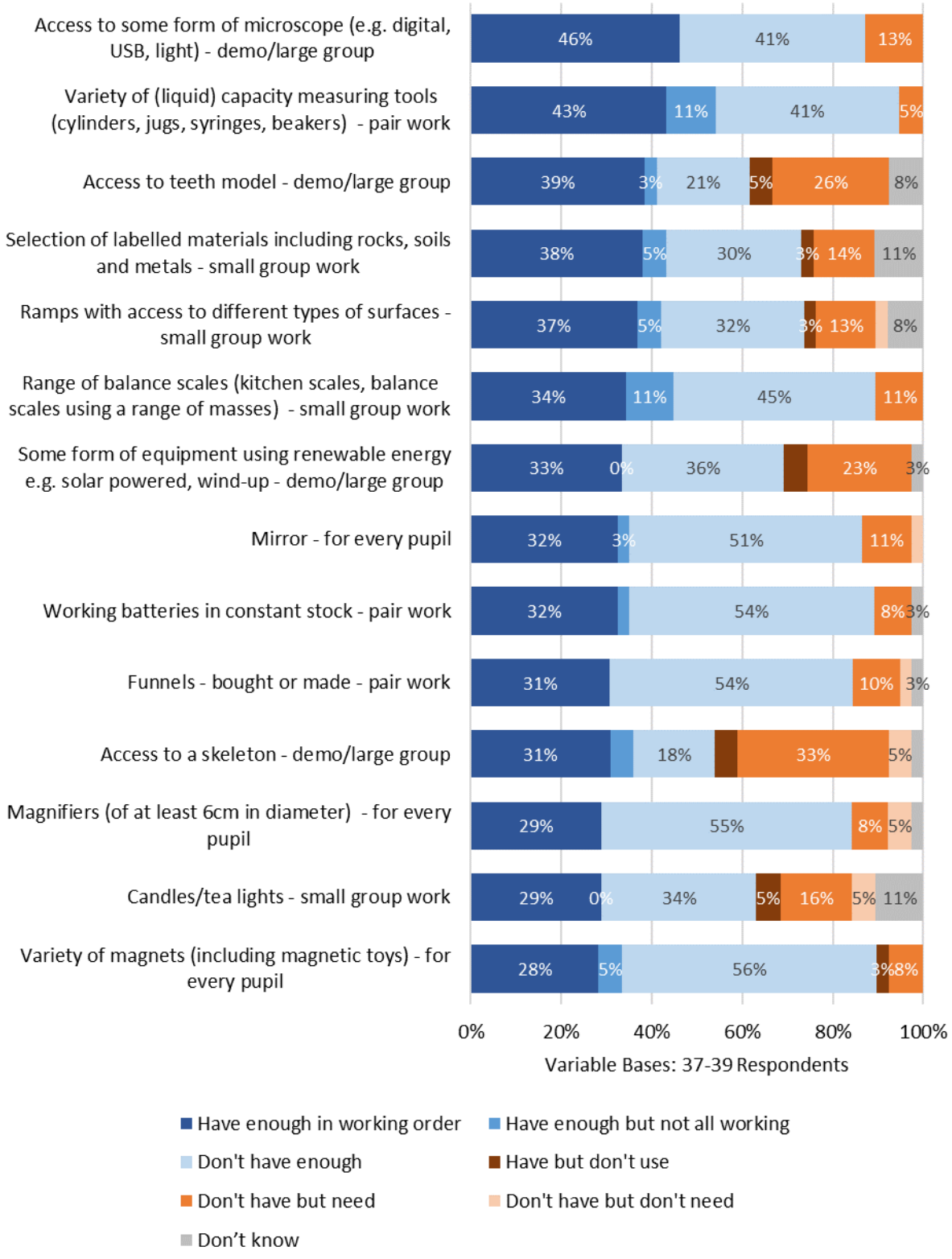
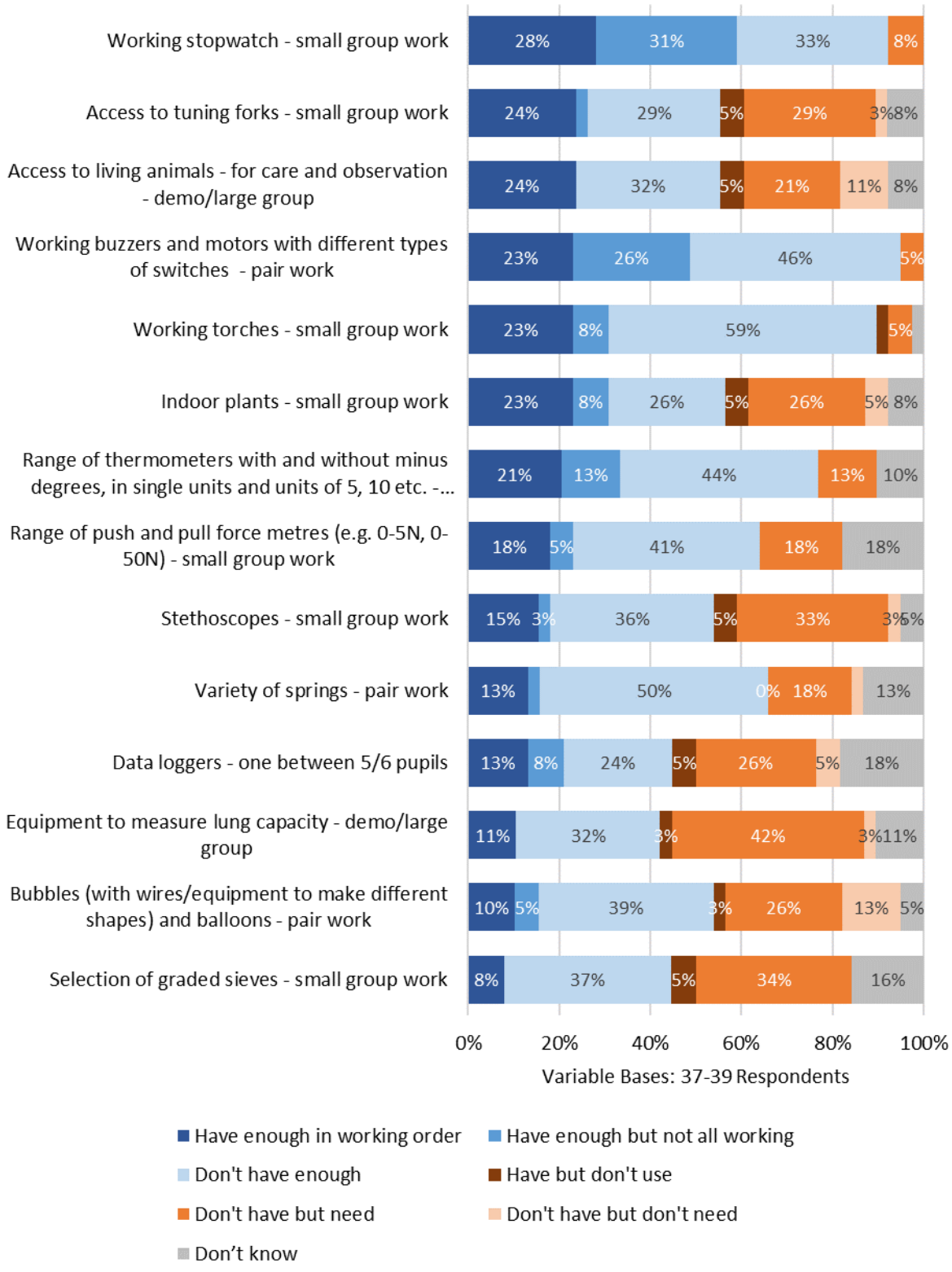


Figure 13 Access to science equipment and consumables (part 2)



Other types of equipment and consumables that primary schools would like access to but do not currently possess, include:

- Data logging and ICT hardware/software to support discrete learning in science and inter-disciplinary use of data and scientific skills (3 respondents);
- Good quality digital and optical microscopes are a priority - especially those that are suitable for learners with special educational needs (2 respondents);
- Chemicals beyond 'kitchen' chemicals, such as copper sulfate ($CuSO_{4)}$ (1 respondent);
- Equipment to demonstrate how the body works, including models, stethoscopes, thermomemeters (1 respondent);
- Resources to examine the changing state of water such as ice lolly moulds and ice cube trays (1 respondent); and
- Lamps and planting materials (1 respondent).

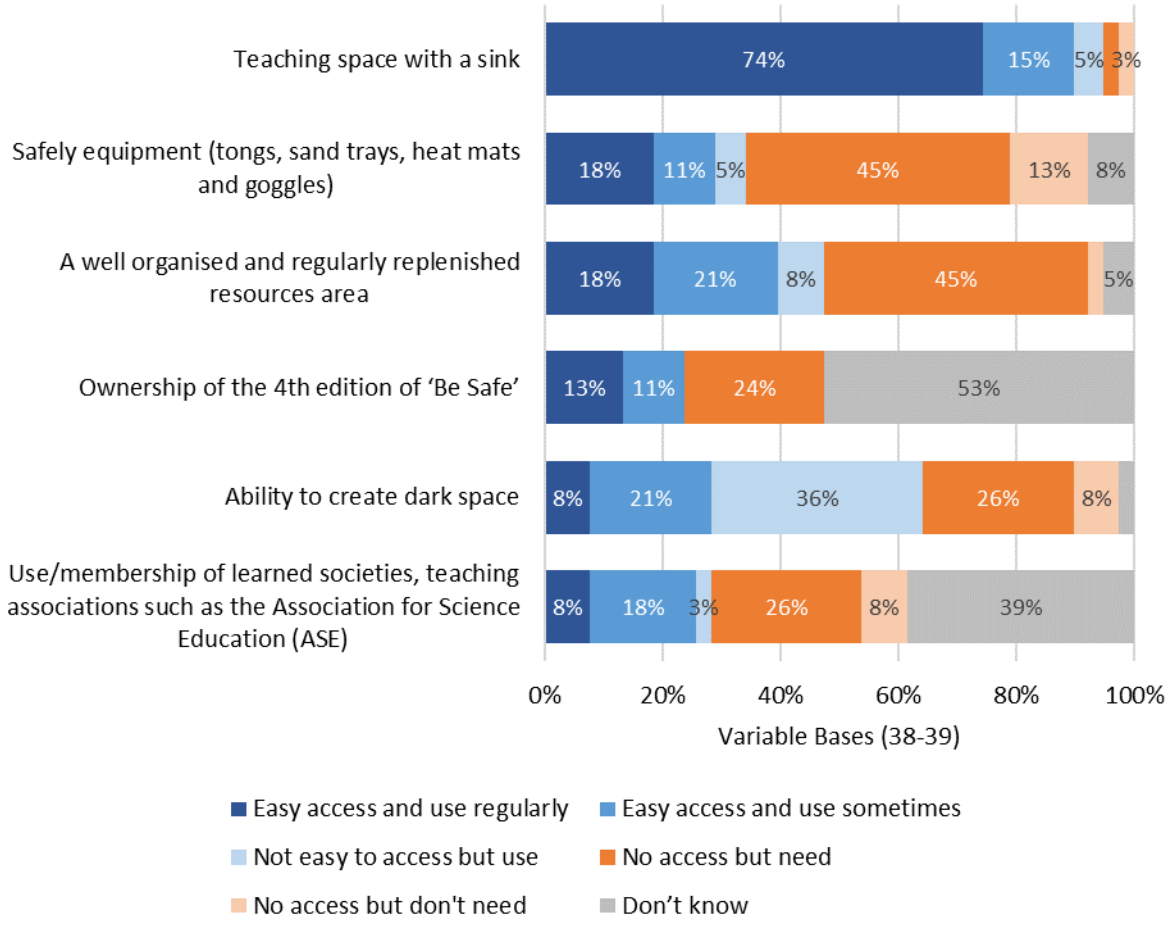
"After having been on the SSERC residential course science is part of our cluster and school improvement plans, and in order for this to be taken forward successfully, we need adequate resources."

2.5 Classroom Facilities and Outdoor Space

Primary schools described their ability to access classroom facilities and outdoor resources that can be used for practical science delivery.

- Almost all schools (89%) have easy access to a sink area and most use this regularly;
- Just under half (45%) report having no access to safety equipment and a well organised and regularly replenished resources area, despite needing these facilities;
- Just over a third of schools (36%) make use of 'dark space' but report that this isn't easy to access (or, presumably, create);
- The majority of schools (53%) do not know if they own the 4th edition of the 'Be Safe!' publication (although it is not clear whether it is the specific edition or the title itself which they are not aware that they hold) – Figure 14.

Figure 14 Access to classroom facilities

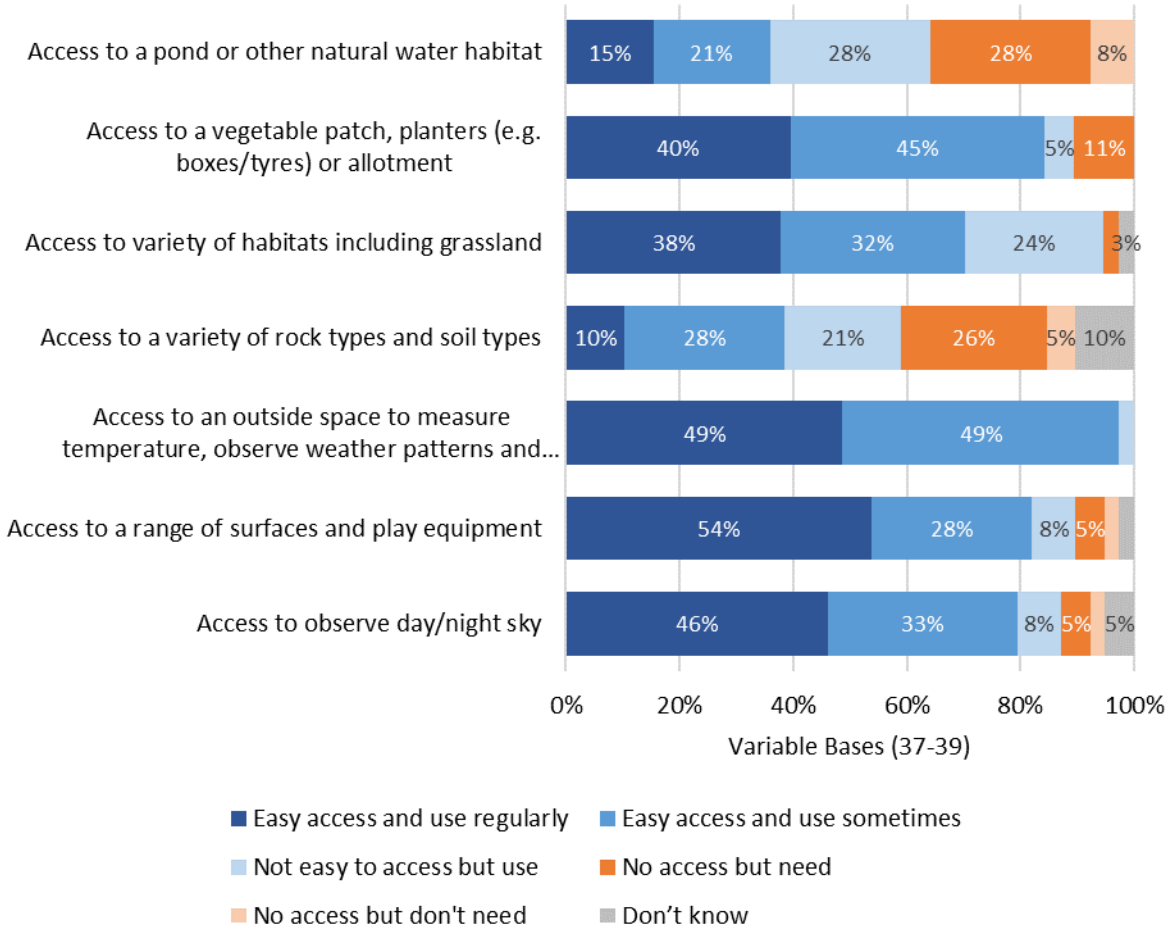


In relation to outdoor space, the majority of primary schools report having easy access to most resources that can be used for practical science delivery during lesson times.

The two main exceptions are:

- Access to a pond or other natural water habitat (28% no access but need); and
- Access to a variety of rock types and soil types (26% no access but need) – Figure 15.

Figure 15 Access to outdoor space



2.6 Barriers to Resourcing Practical Science

Primary school respondents raised a number of issues that they have experienced regarding the resourcing of practical school science.

"Budgets have been cut recently and we are unable to keep up new resources that bring science to life."

The most common theme is that of budgetary limitations. Materials and field trips (for example to science centres) are reported to be expensive and the more costly science equipment can require additional fundraising activities. With lots of other curriculum areas to focus on, school spend on science is not always a priority.

Three schools mentioned that they have either been awarded, or have applied for, a grant from the Edina Trust which they believe will make a positive difference to practical science delivery.

"Unless all staff are confident to teach science, equipment will not be requested or used."

Competence and confidence among teachers is reported to be an issue in some primary schools. Staff do not always know how to use resources to teach effectively and it was suggested that Continuous Professional Development (CPD) could help teachers to overcome these barriers.

One school described how a recently retired member of staff who had expertise in delivering practical science had left a "large gap" in the staffing. Another commented that if their school had access to a classroom assistant to set up and deliver practical sessions, then all children would be able to participate rather than just a teacher-led demonstration.

"Being a small school, space is an issue. It would be useful to have a dedicated area where science could be set up on a permanent basis and resources accessed more easily."

"Finding resources which are good value for money is important."

Three schools described issues associated with supply and procurement, notably that having to use an approved list of suppliers can be restrictive, that desirable items are not always available this way, and that the procurement process can take a long time. One school commented that the use of everyday 'household' items such as lemon juice, vinegar, sugar and corn-flour are normally bought through the school fund and from supermarkets as it can be difficult to order these from the approved list of suppliers.

2.7 Improving the Resourcing of Practical Science

A variety of suggestions were received from primary schools for improving practical science resourcing. These are set out below, ranked from most to least cited:

- More funding for practical science equipment (10 respondents);
- Training/CPD to help improve the expertise of teaching staff in relation to practical

equipment (7 respondents);

- Ring-fenced funding either for science as a subject area, equipment purchasing or replacement/replenishment of equipment (3 respondents);
- A resource list aligned to Scottish curriculum needs (2 respondents);
- More information about where to find resources and optimise value for money among the approved range of suppliers (2 respondents);
- Better information about grants that may be available (2 respondents);
- Freedom to procure equipment from anywhere (1 respondent);
- A shared 'resource bank' for use between schools (1 respondent);
- Making the resourcing of practical science a national priority (1 respondent);
- Access to equipment that is specifically designed for pupils with special educational needs (1 respondent).

"The SSERC mentor training has been invaluable to the individual teacher and is starting to impact on schools."

"The Curriculum for Excellence gives clear guidance regarding skills development. A clear city-wide plan would be appreciated."

"As Science Mentors for our cluster, we have created a bank of resource boxes to ensure that most areas of the curriculum can be taught effectively. Schools will be responsible for replacing consumable items but the main equipment will be maintained centrally. It would be good if we did not have to access everything through official school suppliers as many small things can be far more cheaply bought through local supermarkets and chemists."

Part B:

Secondary Schools

Findings

3. Secondary Schools – Findings

3.1 Teaching of Science

Among surveyed secondary schools, an average of 7.8 teachers (full time equivalent) are allocated to teaching the sciences. The lowest recorded is one teacher and the highest is 15 teachers.

On average, each school employs an average of 1.8 technicians and the majority (55%) are full-time throughout the whole year (Table 5).

Table 5 Science Technicians – Full-time/part-time status

Full/part time	% share
Full-time all year	55%
Full-time term time only	13%
Part-time all year	16%
Part-time term time only	16%

Base: 39 respondents

An average of 45 technician hours are worked per week during term time (two schools reported zero hours) and an average of 32 hours are worked per week outside of term time (six schools reported zero hours).

Most teaching time for science appears to take place in year S5, with an average of 270 minutes per week (Table 6).

Table 6 Teaching Time for Science

Type of school	Avg. teaching time p/week (minutes)	Minimum recorded	Maximum recorded
S1	160	100	210
S2	158	100	210
S3 (per course)	147	60	225
S4 (per course)	197	134	275
S5 (per course)	270	165	360
S6 (per course)	242	50	330

Base: 41-45 respondents

Secondary schools were asked to indicate the proportion of science teaching time allocated to practical work across four levels. The results reveal a gradual drop from an average of 46% in Broad General Education, to 24% at Advanced Higher level (Table 7).

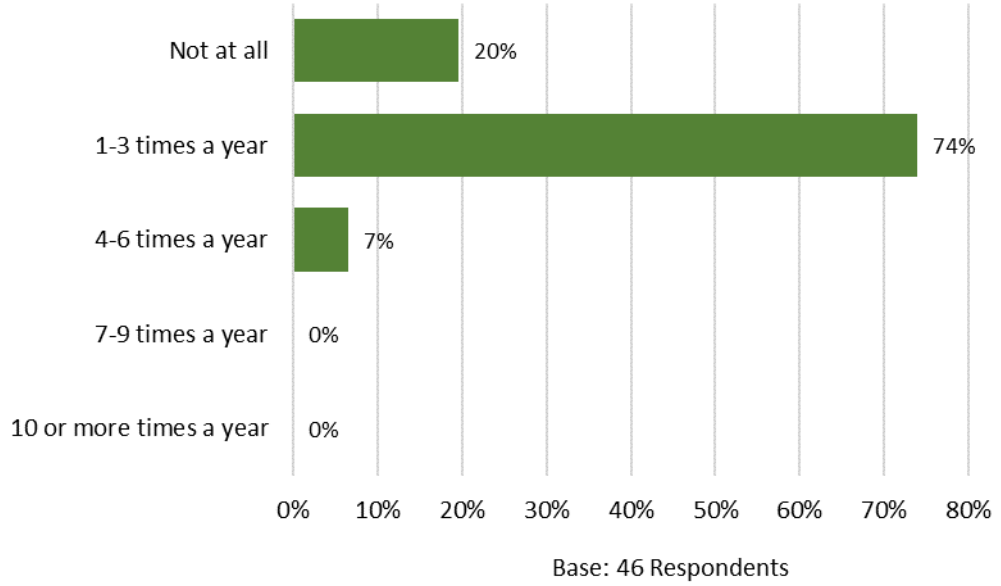
Table 7 Proportion of teaching time allocated to science practical work

Type of school	Avg. % share	Minimum recorded	Maximum recorded
Broad General Education	46%	8%	80%
National	32%	5%	70%
Higher	25%	1%	70%
Advanced Higher	24%	1%	70%

Base: 41-43 respondents

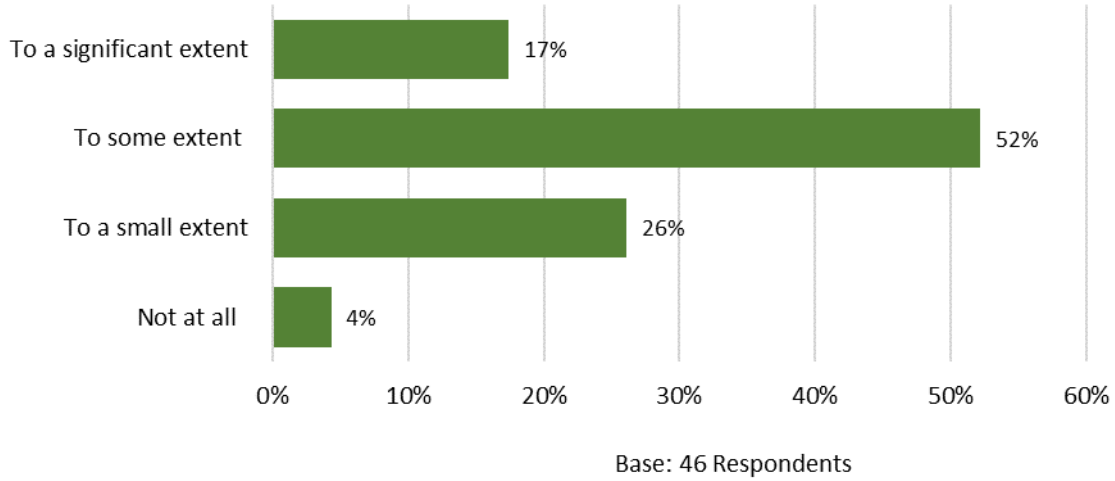
Three quarters of secondary schools (74%) invite people in from outside the school between one and three times per year to help provide practical science demonstrations, while a fifth do not bring in any external assistance in this way (Figure 16).

Figure 16 How often people from outside the school help with science demonstrations



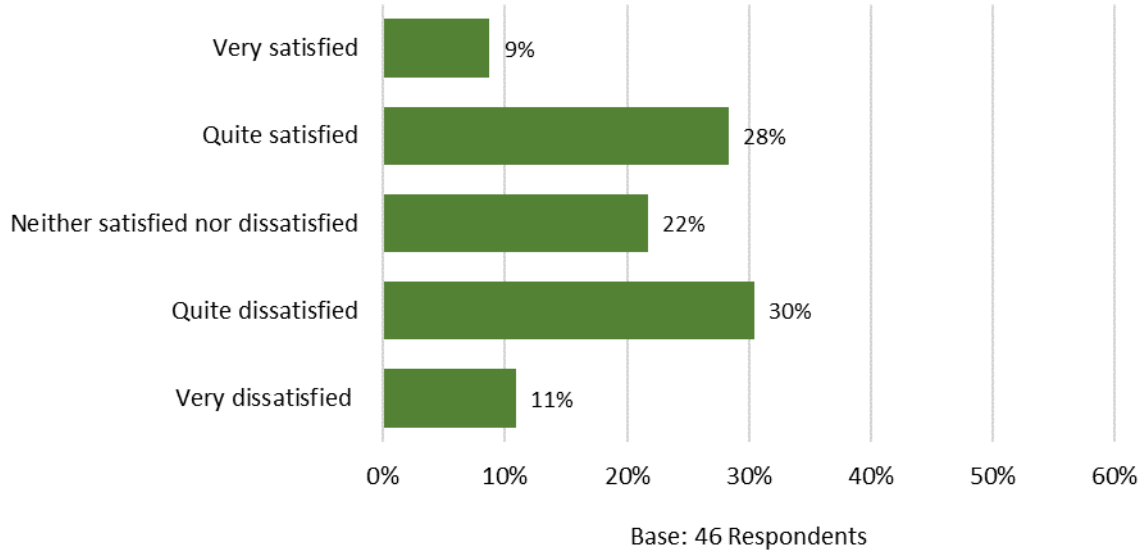
Almost all (96%) of secondary schools said that they use new forms of Information Technology to deliver practical science experiments, with most stating that they use these facilities "to some extent" (Figure 17).

Figure 17 Use of new technologies/IT to deliver practical science experiments



Perceptions are varied concerning whether science departments feel they have sufficient technician support to deliver effective science practical work. Just under half (41%) are dissatisfied, with a further 22% ambivalent (Figure 18).

Figure 18 Satisfaction with amount of science technician support



3.2 Funding for Science

The average spend on science among surveyed secondary schools has grown from £5,359 (2012-13) to £5,590 (2013-14) – a rise of 4% (Table 8).

The average spend on science per capita has increased from £7.03 (2012-13) to £7.33 (2013-14). The lowest recorded per capita spend in 2013-14 is £2.00 and the highest is £25.60.

Table 8 School Science Spend

Year[7]	Average school spend on science	Minimum	Maximum	Average school spend on science per capita
2013-14	£5,590	£300	£15,103	£7.33
2012-13	£5,359	£200	£13,700	£7.03

Base: 44 respondents

Over the course of the next year, the level of spend on science is estimated to contract by an average of 7% among surveyed schools.

Of 44 schools that provided an estimated change percentage, the results are varied:

- A small minority (2) expect an increase (reporting 10% and 15% respectively);
- Just under half (21) expect science spend to remain at the same level as the current year; and
- Just under half (21) expect a decrease (ranging from 2% to 70%).

Almost all (90%) of surveyed schools reported that the entire science budget is available for science departments to spend at their own discretion.

The allocation of the science budget appears to be relatively evenly spread across the distinct science subject areas (Table 9).

[7] Schools used their discretion as to whether they defined the year bands as financial year or academic year.

Table 9 Allocation of science budget by subject area[8]

Year	Spend	% mix
Biology	£1,392	28%
Chemistry	£1,207	25%
Physics	£1,113	23%
Science	£1,158	24%

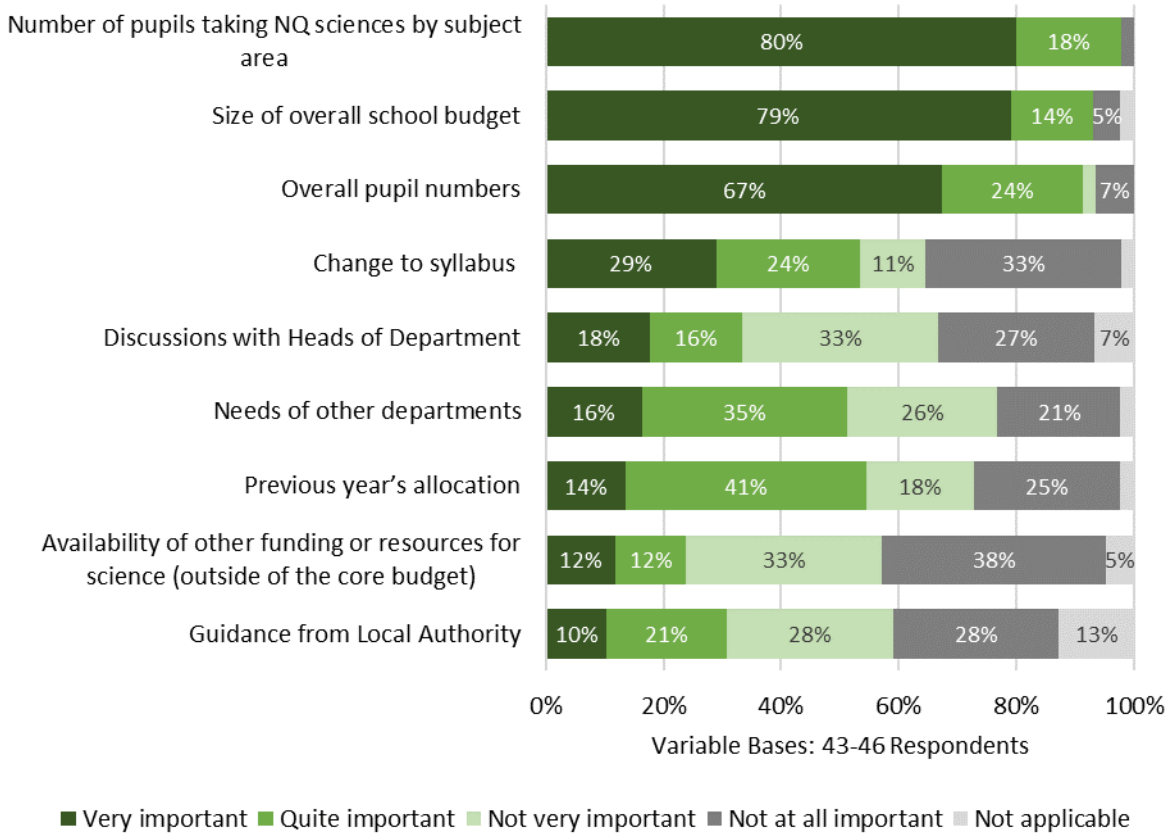
Base: 37-39 respondents

Secondary schools were asked to rate the importance of a number of factors when deciding how much funding to allocate to science. The most important of these are:

- Number of pupils taking NQ sciences by subject area
- Size of overall school budget; and
- Overall pupil numbers (Figure 19).

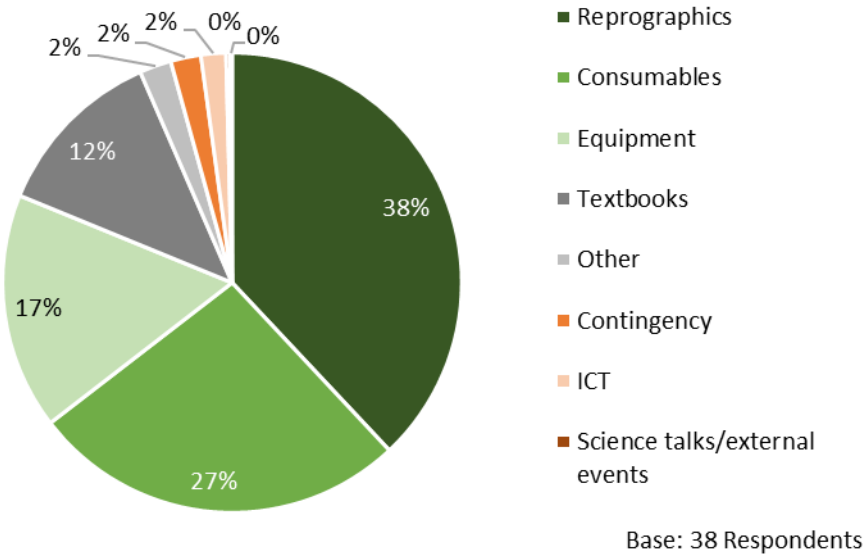
[8] The average spend across all discrete science subject areas in Table 9 equates to £4,870. This is lower than the total science spend of £5,590 for 2013-14 shown in Table 8. The difference may be explained on the basis that: 1) The information feeding into these Tables was gathered as part of separate questions and the base number of respondents for each question was different; and 2) Some respondents did not provide matching information, i.e. the amount of science spend for discrete subjects did not always equal the amount given for total science spend. As it is not possible to determine the correct information, the data should be treated with caution.

Figure 19 Importance of factors when allocating funding available for science



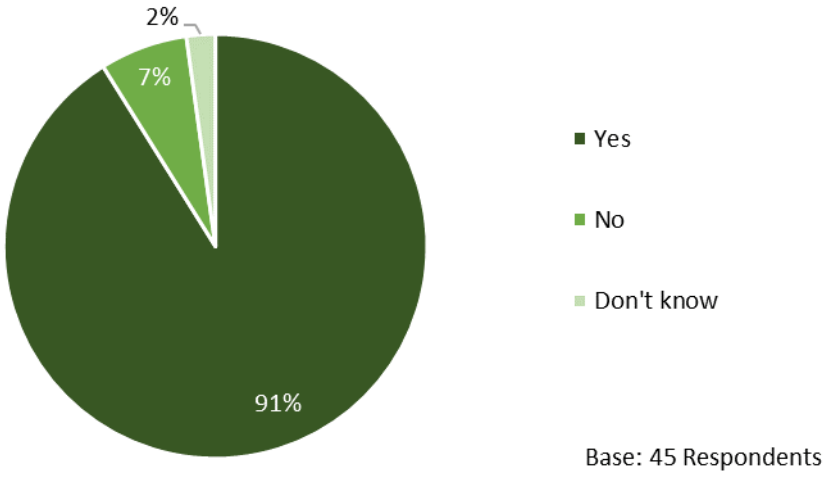
The largest area of science budget spend among secondary schools is reprographics (38%) followed by consumables (27%) and equipment (17%) – Figure 20.

Figure 20 Allocation of the science budget across all year groups



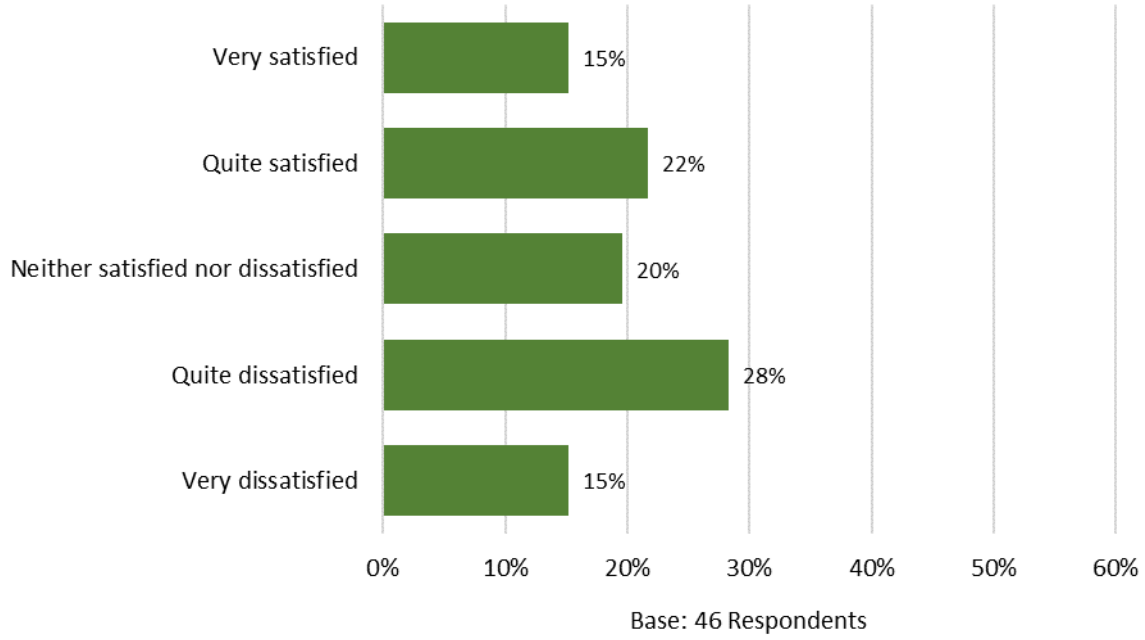
Almost all secondary schools (91%) confirmed that they are required to spend their science budget within the full year and that monies cannot be rolled on to the following year (Figure 21).

Figure 21 Whether the science budget must be spent in the current year



There are varying levels of satisfaction concerning whether school science departments spend their budget in the most appropriate way (Figure 22).

Figure 22 Satisfaction that science departments spend money in the appropriate way

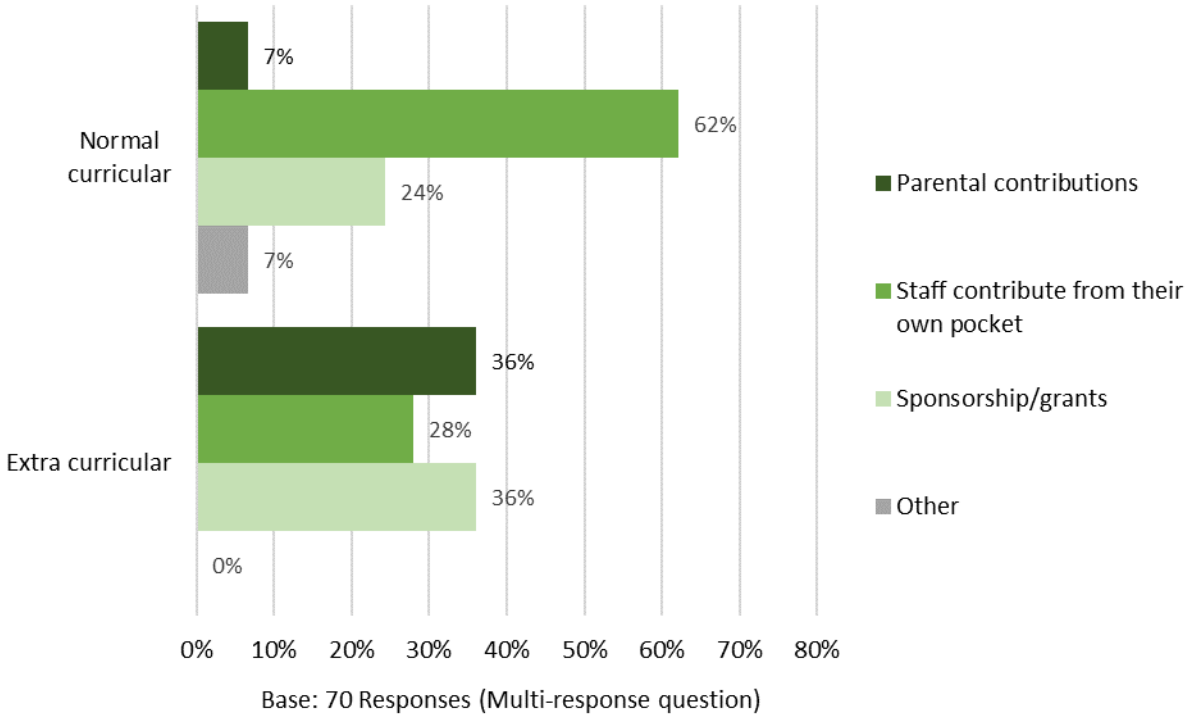


3.3 Funding for Science Practical Work

All surveyed secondary schools stated that they do not ring-fence any part of the science budget specifically for science practical work.

All but one secondary school (98%) reported using at least one additional source of funding to support science practical work. For normal curricular activities staff appear to commonly contribute from their own pocket, whereas parental contributions and sponsorship grants are the most popular additional sources of funding for extra-curricular activities (Figure 23).

Figure 23 Additional sources of funding for science practical work

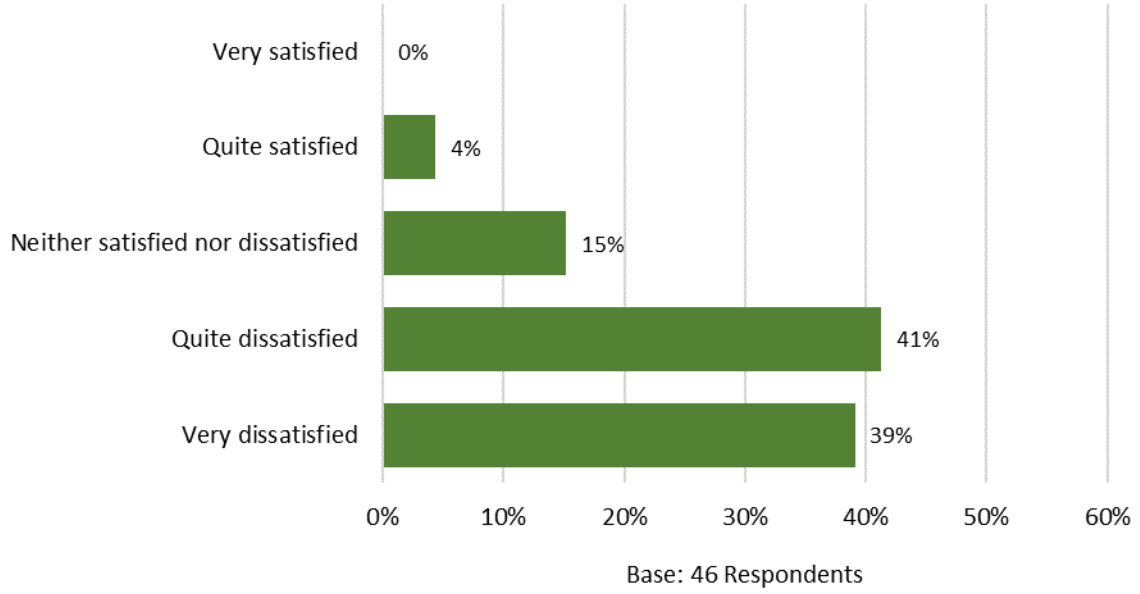


Sources listed as 'Other' include:

- 'Enthuse' grants for training;
- Fundraising, including pupil enterprise activities to pay for trips;;
- Use of teachers' home resources;
- RSC grant for chemistry outreach project to local primary schools.

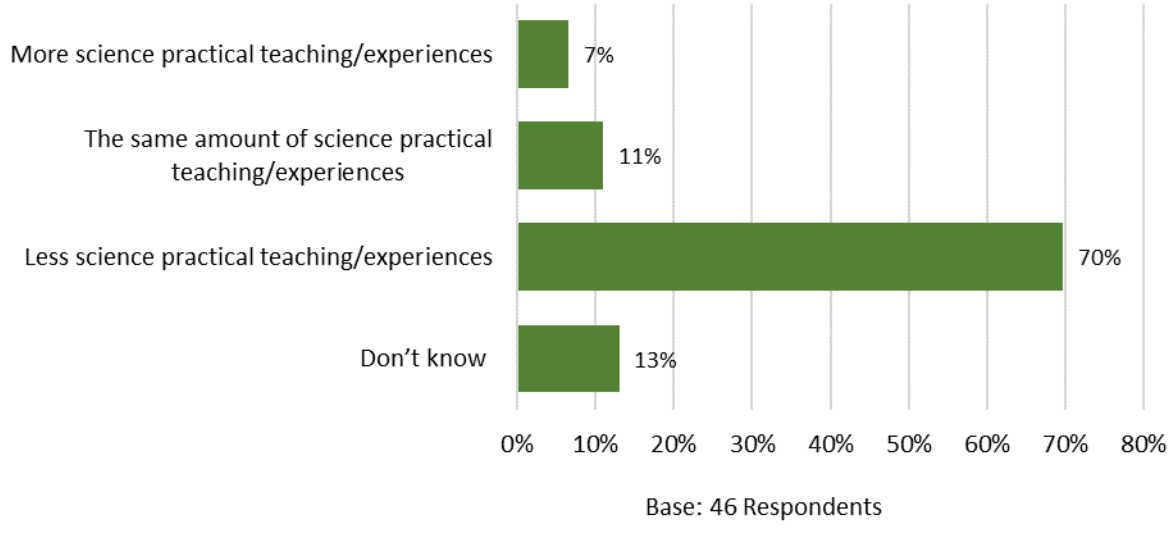
The majority (80%) of schools are not satisifed that they have sufficient funding available for science practical work with most of the remainder ambivalent (Figure 24)

Figure 24 Satisfaction with funding for science practical work



Most schools (70%) are of the opinion that any changes to the science budget over the next two years will result in less science practical teaching/experiences (Figure 25).

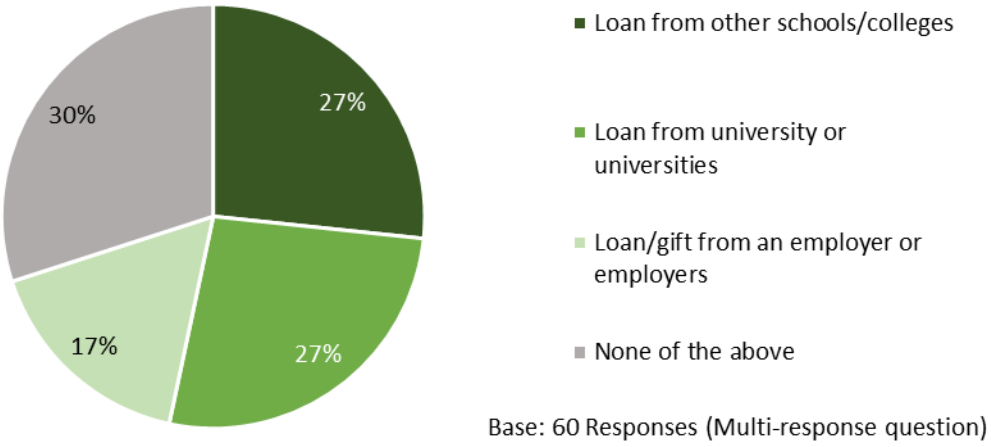
Figure 25 Anticipated changes over the next two years



3.4 Science Equipment and Consumables

The majority of surveyed secondary schools report having been gifted or loaned equipment or consumables for practical science. The most popular sources are other schools, colleges and universities (and to a lesser extent employers) – Figure 26).

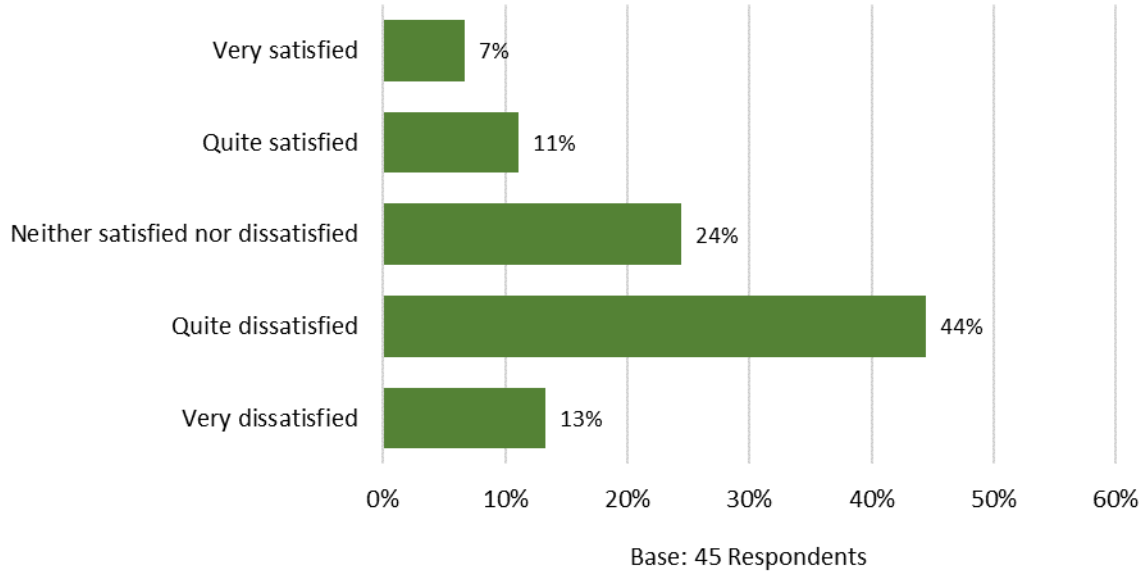
Figure 26 Sources of practical science equipment and consumables



Base: 60 Responses (Multi-response question)

Over half (57%) of secondary schools believe they have insufficient equipment and consumables to deliver science practical work effectively (Figure 27).

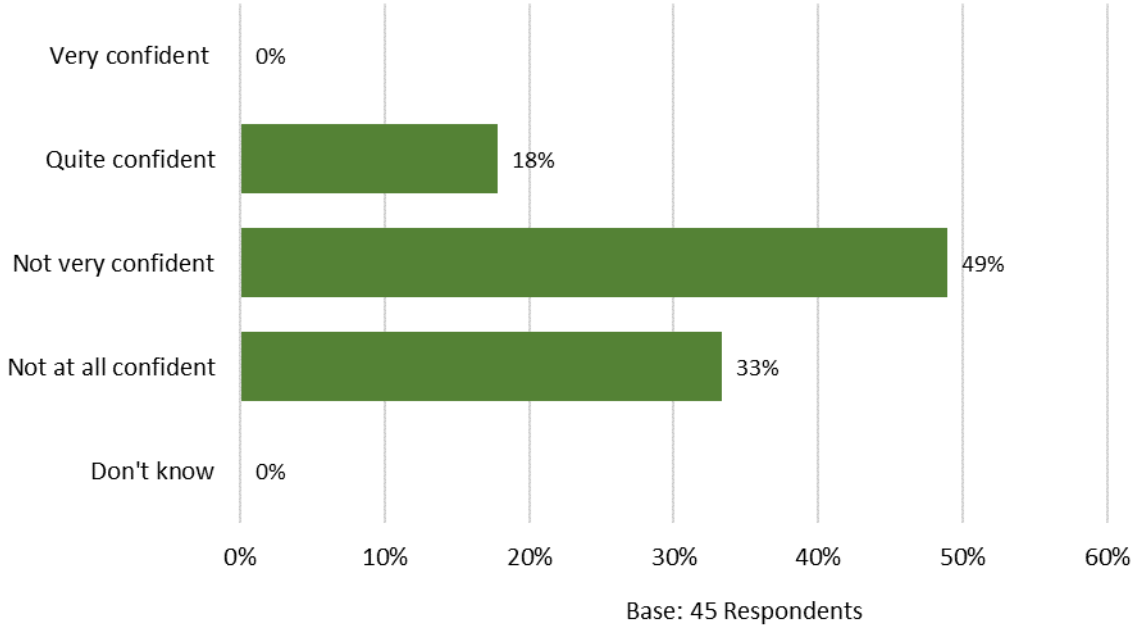
Figure 27 Satisfaction with current amount of science equipment and consumables



Base: 45 Respondents

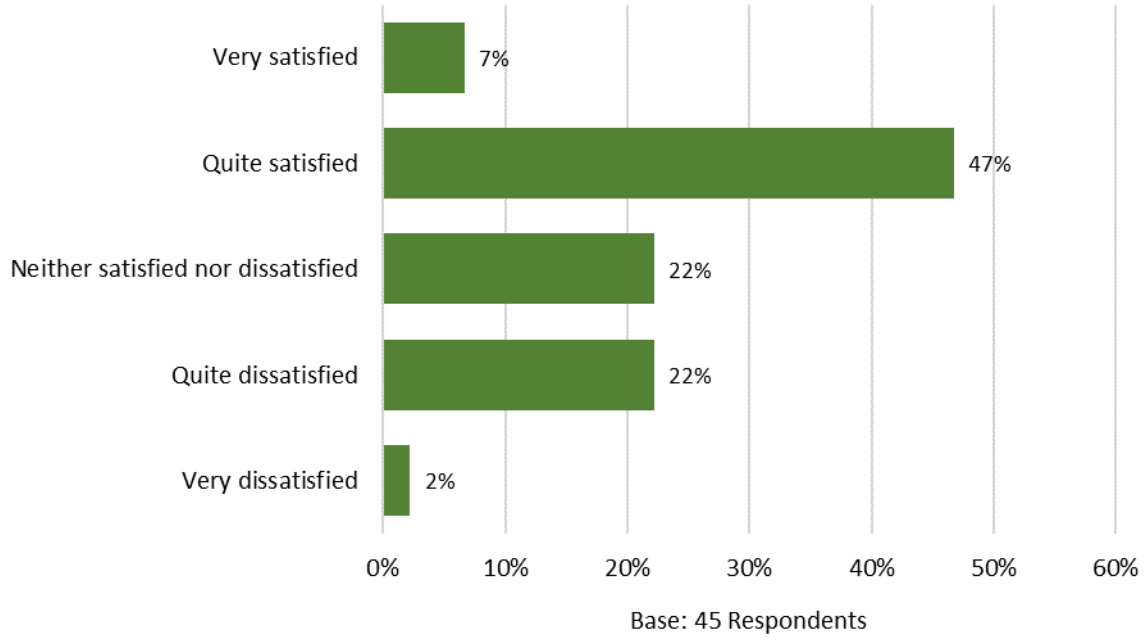
Looking towards the future, more than eight out of ten secondary schools are not confident of having enough equipment and consumables to deliver science practical work effectively (Figure 28).

Figure 28 Confidence in having enough science equipment over the next two years



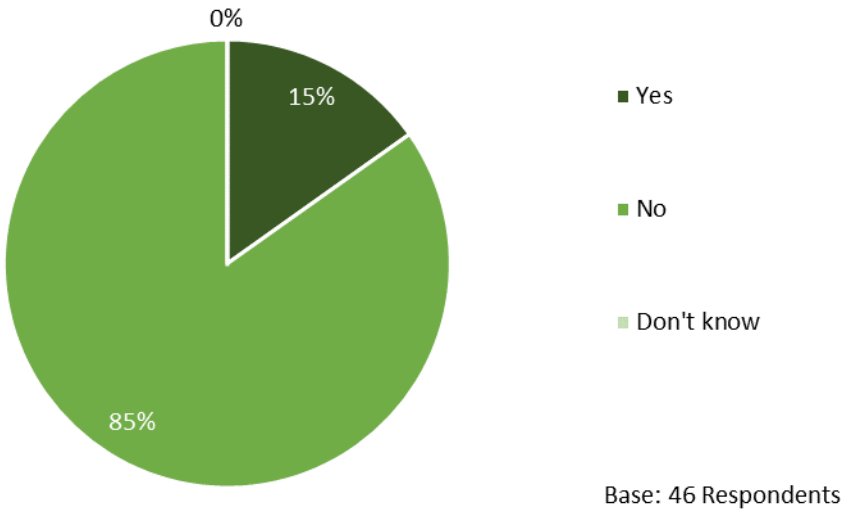
Over half of secondary schools (54%) are satisfied with access to training available on the use of science equipment and consumables (Figure 29).

Figure 29 Satisfaction with access to training on science equipment and consumables



Most secondary schools (85%) confirmed that they are not free to choose which supplier of science equipment and consumables offer the best value for money (Figure 30).

Figure 30 Whether free to schools the supplier of science equipment and consumables



Respondents were asked to indicate the level and condition of specific equipment and consumables that can be used for practical science delivery, in relation to their needs. For each item of equipment schools were asked to select whether they:

- Have enough in working order;
- Have enough but not all working;
- Don't have enough;
- Have but don't need;
- Don't have but need; or
- Don't have but don't need.

The full results are presented in Figures 31 to 37 for each of the following levels and subject areas:

- Pre-16 biology;
- Post-16 biology;
- Pre-16 chemistry;
- Post-16 chemistry;
- Pre-16 physics;
- Post-16 physics; and
- General science equipment for ages 11 to 19.

Table 10 summarises the 'most needed' items from each level and subject area.

Table 10 Most needed items – Biology, Chemistry, Physics and General Education

Level	Don't have enough	Don't have but need
Pre-16 Biology	Breathing, exercise, temperature change and blood pressure (heart rate) change equipment Equipment to measure changes in the body e.g. temperature, blood pressure, heart rate	Klinostat Digital microscope with visualiser/flexi-camera
Post-16 Biology	Top pan balance +/- 0.001g Colorimeter	Genetic engineering kits Digital microscope with visualiser/flexi-camera/stage micrometers
Pre-16 Chemistry	Balance ± 0.01 g Ground glass gas syringe	Variety of smart materials Rock and mineral kit
Post-16 Chemistry	Balance ± 0.001 g Büchner funnel and flask and appropriate method for generating suction	TLC plates Balance ± 0.001 g
Pre-16 Physics	UV + infrared kit (sources and detectors) Energy meter	UV + infrared kit (sources and detectors) Variety of magnets including alnico, magnadur and neodymium
Post-16 Physics	Balance (±0.01 gram) Vernier callipers	Hall effect probe/search coil and solenoids (with iron cores) Microwave kit
General	Data logger and computer with range of sensors (e.g. Temperature, pH, sound) Heated magnetic stirrers	N/A

Figure 31 Access to science equipment and consumables (Pre-16 Biology)

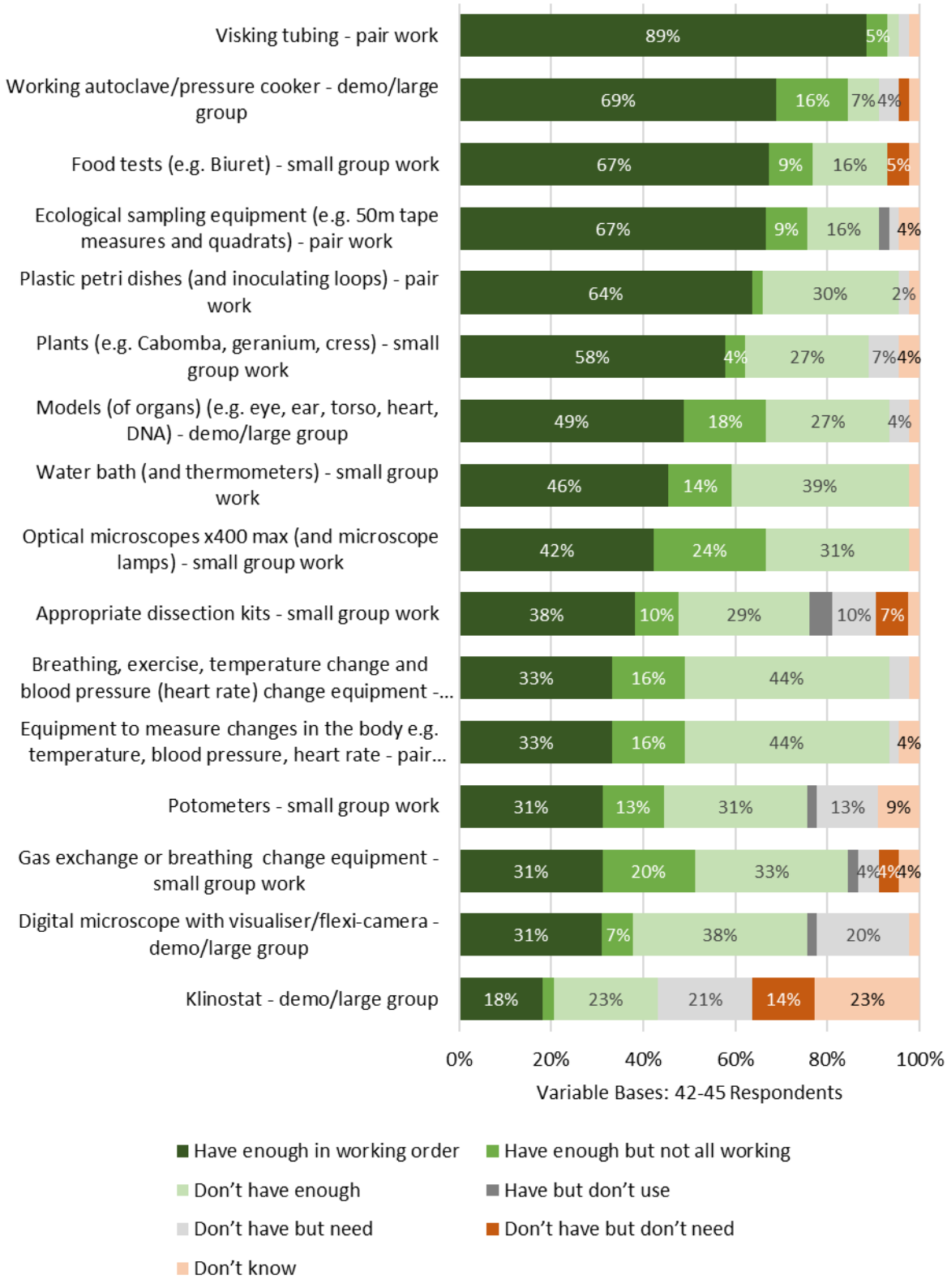


Figure 32 Access to science equipment and consumables (Post-16 Biology)

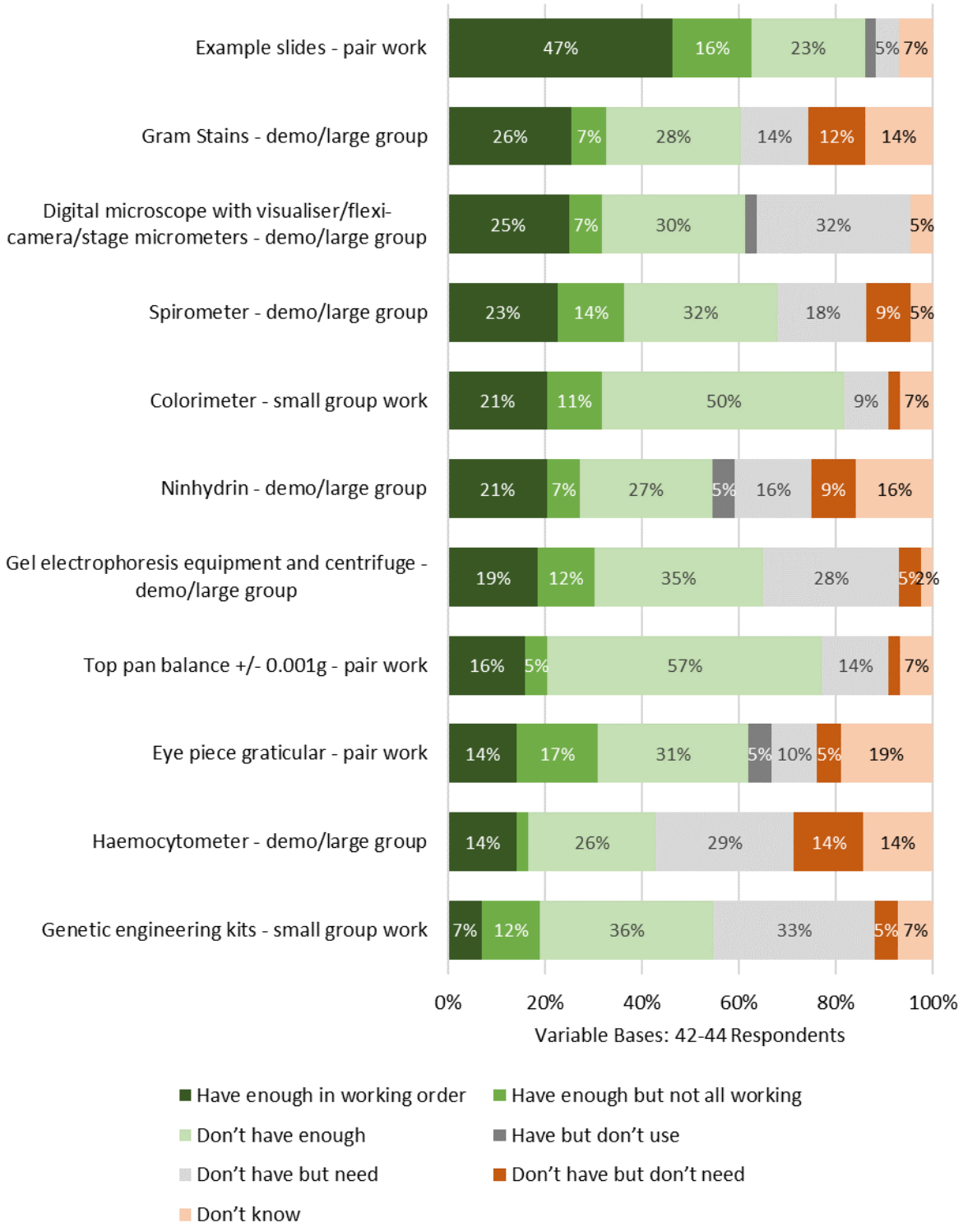


Figure 33 Access to science equipment and consumables (Pre-16 Chemistry)

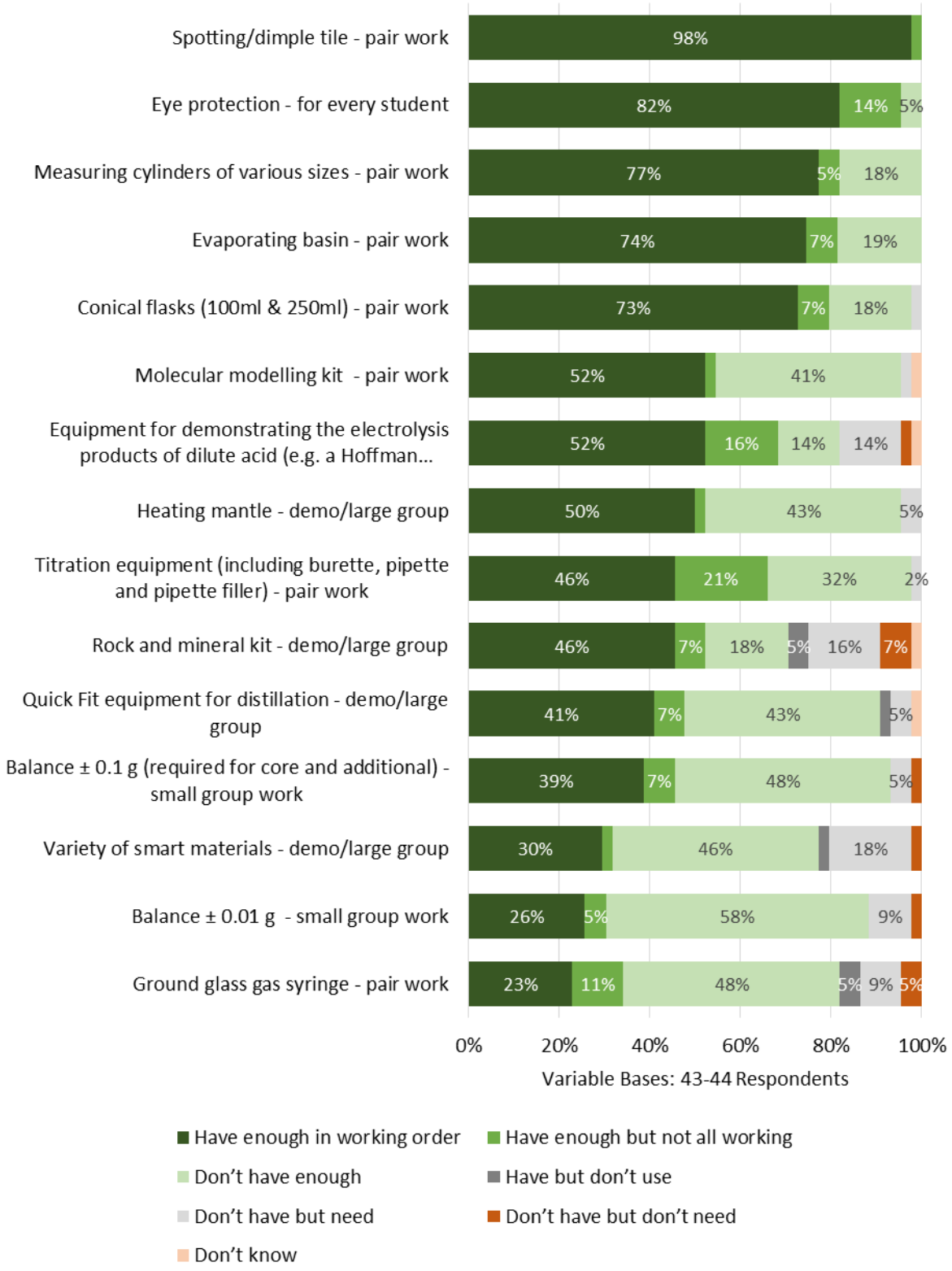


Figure 34 Access to science equipment and consumables (Post-16 Chemistry)

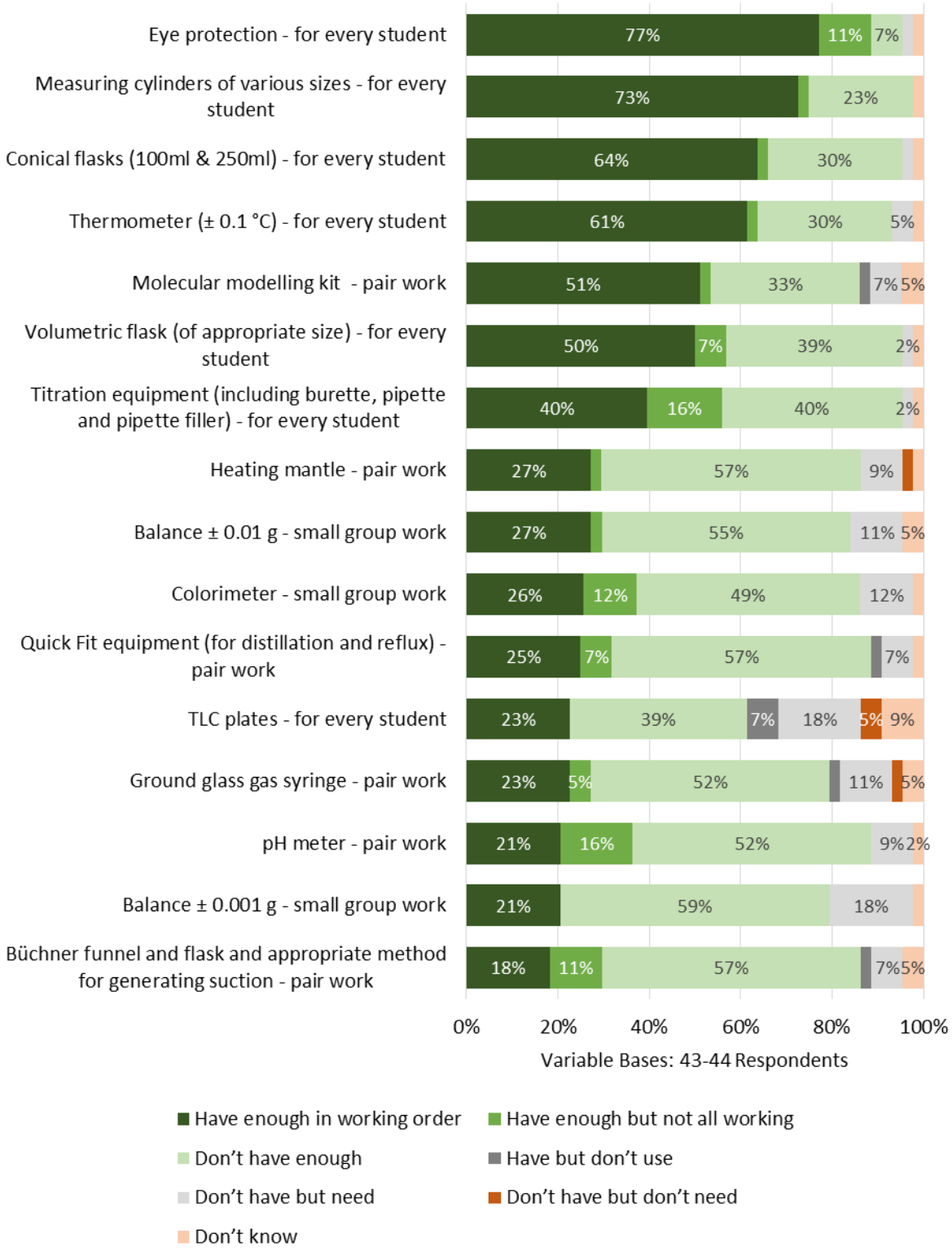


Figure 35 Access to science equipment and consumables (Pre-16 Physics)

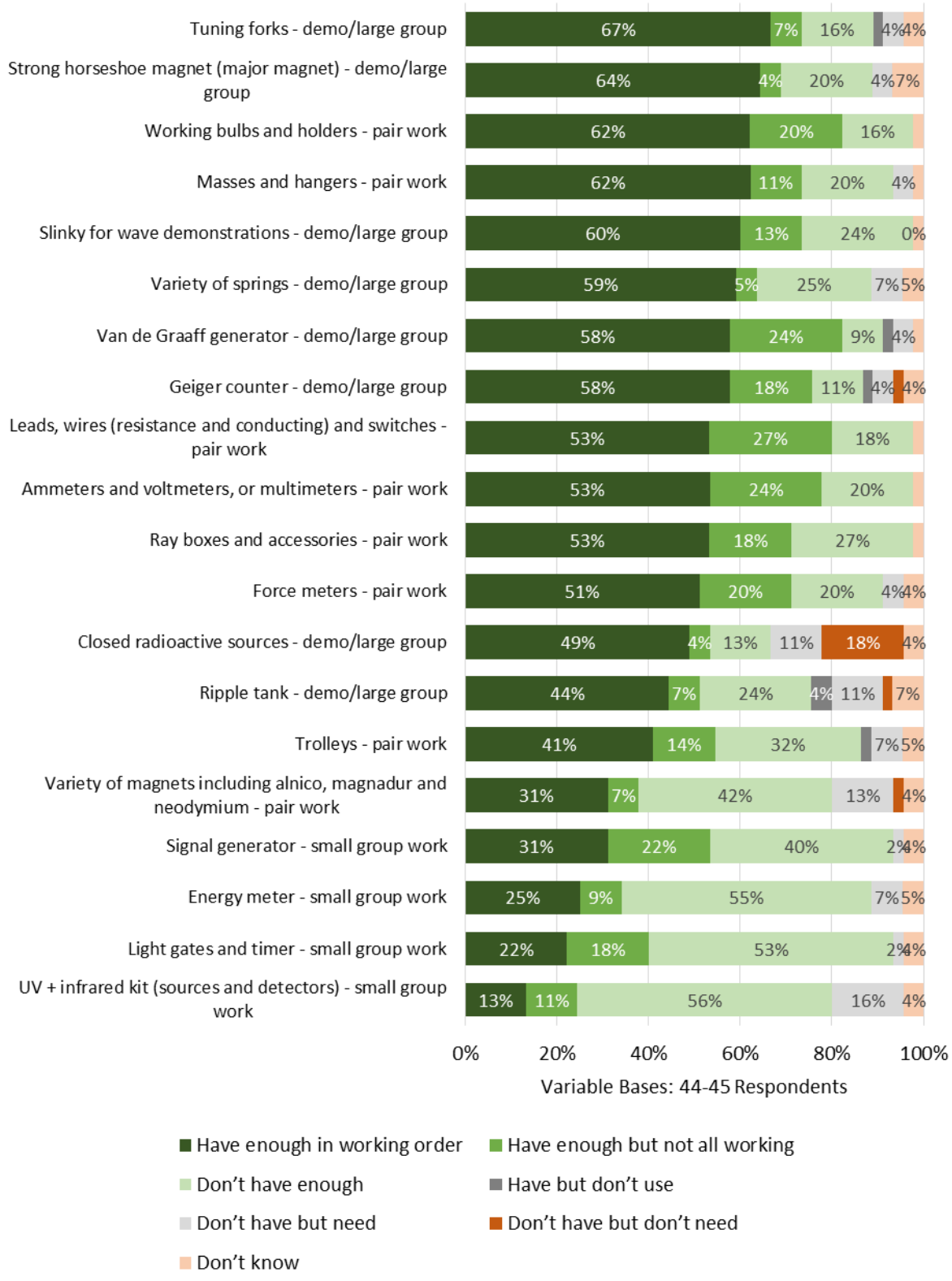


Figure 36 Access to science equipment and consumables (Post-16 Physics)

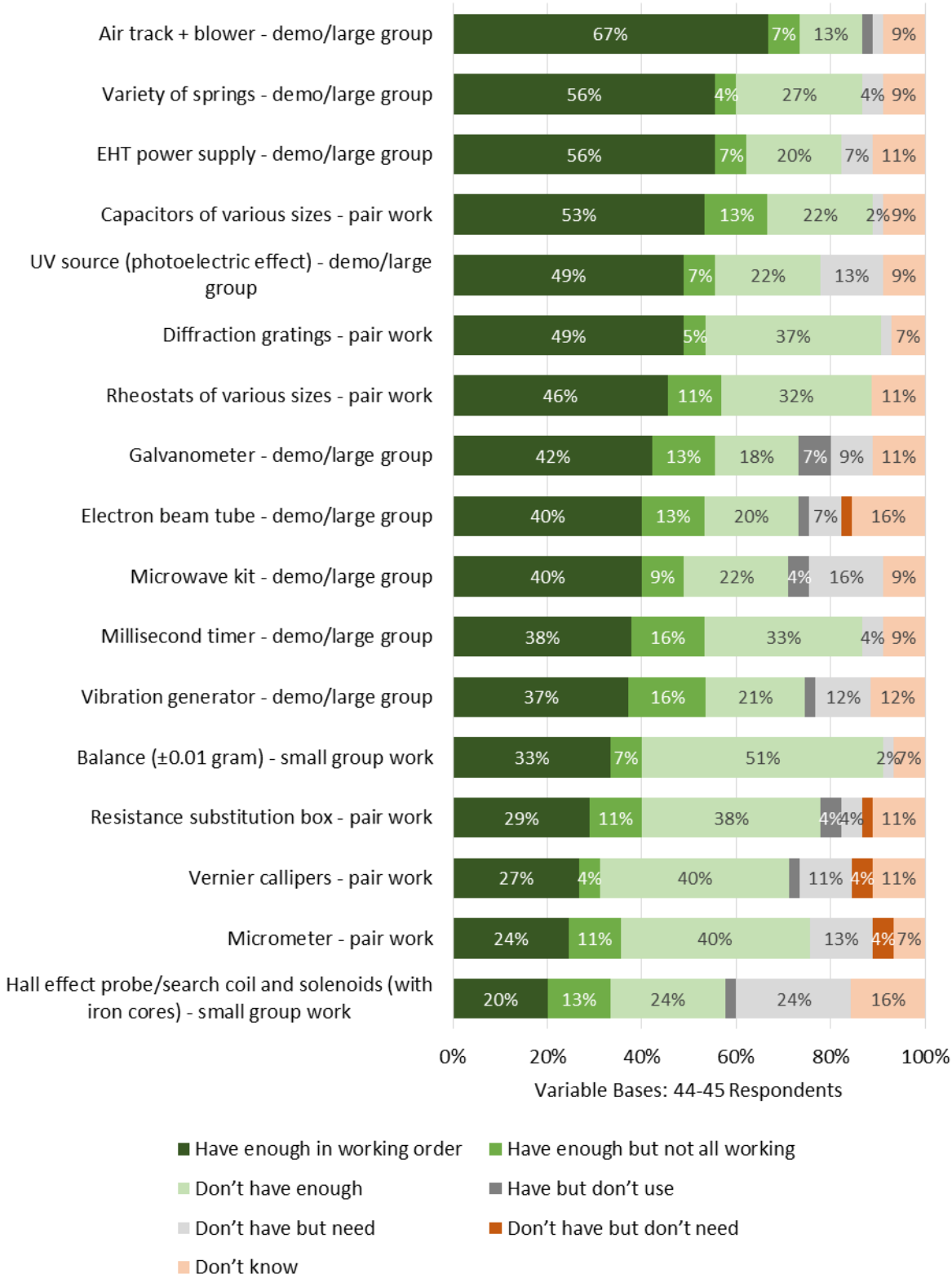
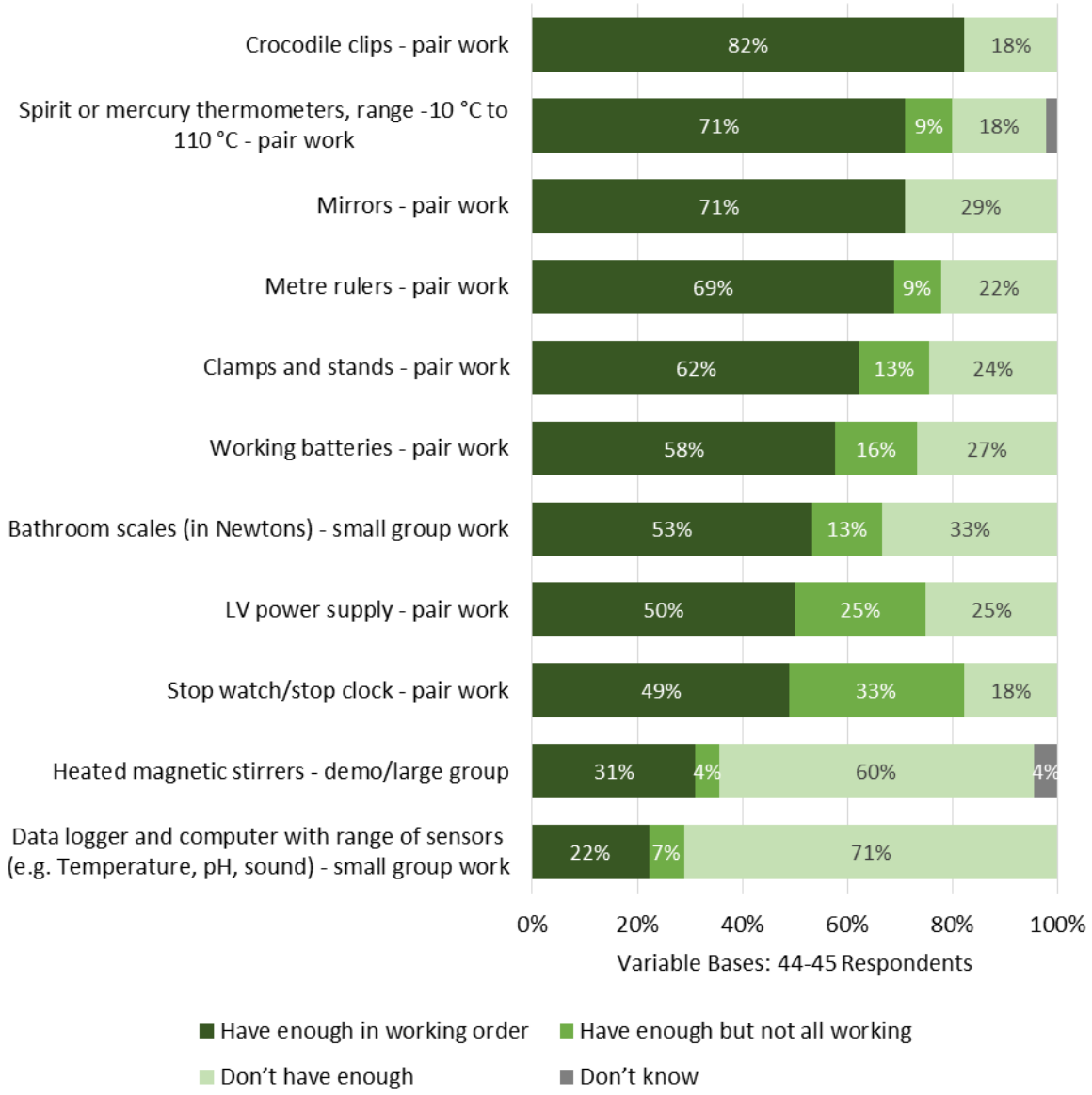


Figure 37 Access to science equipment and consumables (General 11-19)



Respondents were asked to list other items of equipment and consumables that science departments would like access to but do not currently possess . The most commonly mentioned were IT and data logging equipment that is affordable, current (i.e. still supported by the manufacturer) and that will allow the amount of data logging required by the latest qualifications (CfE Highers in particular were mentioned).

Other items (generally mentioned once by individual schools) are as follows:

- Basic glassware;
- Bulbs;
- Chemicals for protein gels;
- Distillation apparatus;
- Electrophoresis consumables;
- Gas discharge tubes;
- Ground glass syringe;
- Heating mantles;
- Interactive software packages for use on the electronic whiteboard (cost is the issue);
- Lab jacks and quick fit glassware for S5/6 chemists (as new CfE Higher will require more);
- LV power supplies;
- Microbiology equipment for aseptic technique;
- Microscopes;
- Molecular biology equipment;
- Multi-meters;
- Oscilloscopes;
- PCR machine with associated consumables (high cost prohibits this, but is required for the new Higher Biology);
- Petri dishes;
- Protective eye gear;
- Radioactivity resources;
- Signal Generators, and
- UV meters.

"The majority of physics equipment is over 40 years old. It is damaged, broken or not working and far too expensive to replace."

"It becomes very frustrating for pupils when the procedures they wish to follow are so limited by the level of sophistication of our equipment. We are particularly lacking in IT equipment to support our teaching of science."

"Students invariably have to work in large groups or have to share equipment with other classes, or do not do particular practical sessions due to the lack of suitable equipment."

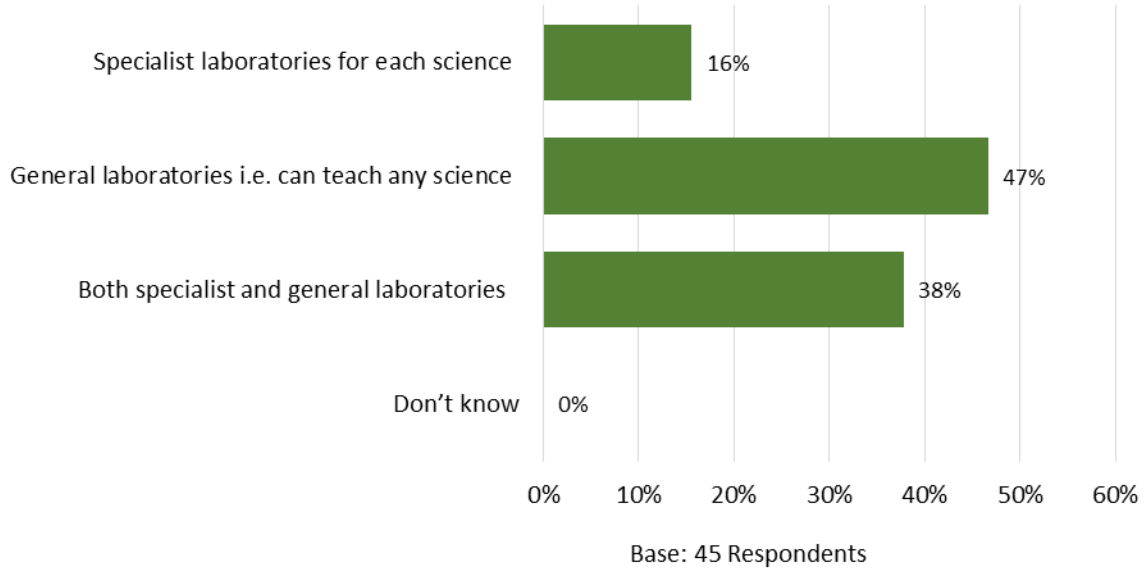
3.5 Laboratory Facilities

Each secondary school has an average of nine laboratories (the minimum reported is 2 and the maximum is 17).

A total of 44 schools responded to a question which asked whether they have laboratories available for all science classes each week. Of these, a total of 86% confirmed that they do, with six schools (14%) stating that this is not the case. Among these six schools, an average of three hours of lesson time, per week, are not taught in a laboratory.

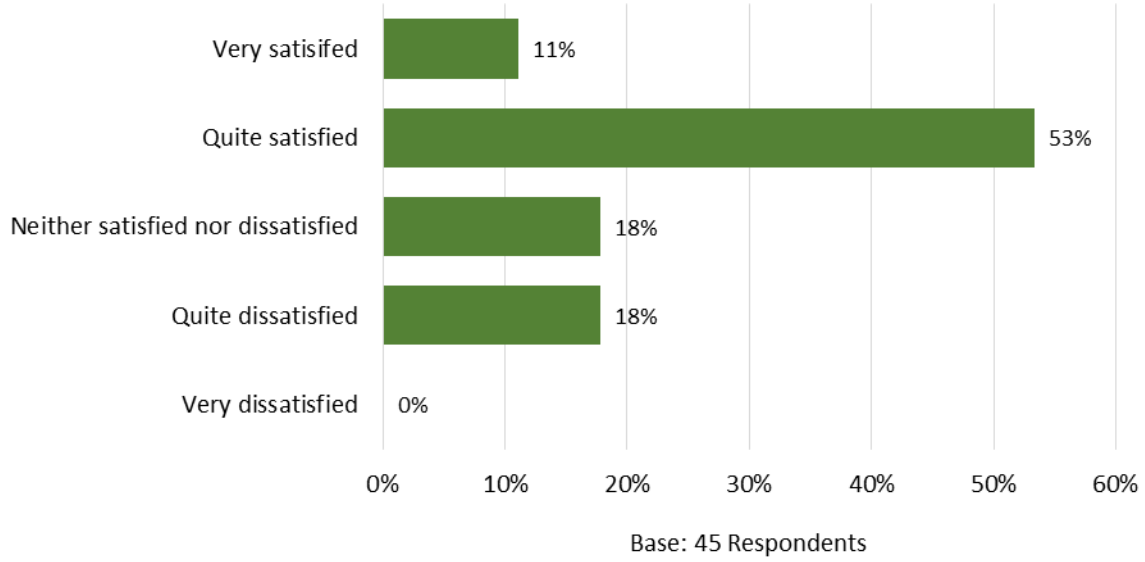
Laboratories are set up and used different ways. Just under half of schools share all laboratories between different science subjects, whereas a smaller proportion (16%) use specialist laboratories for each subject (Figure 38).

Figure 38 How laboratories are set up



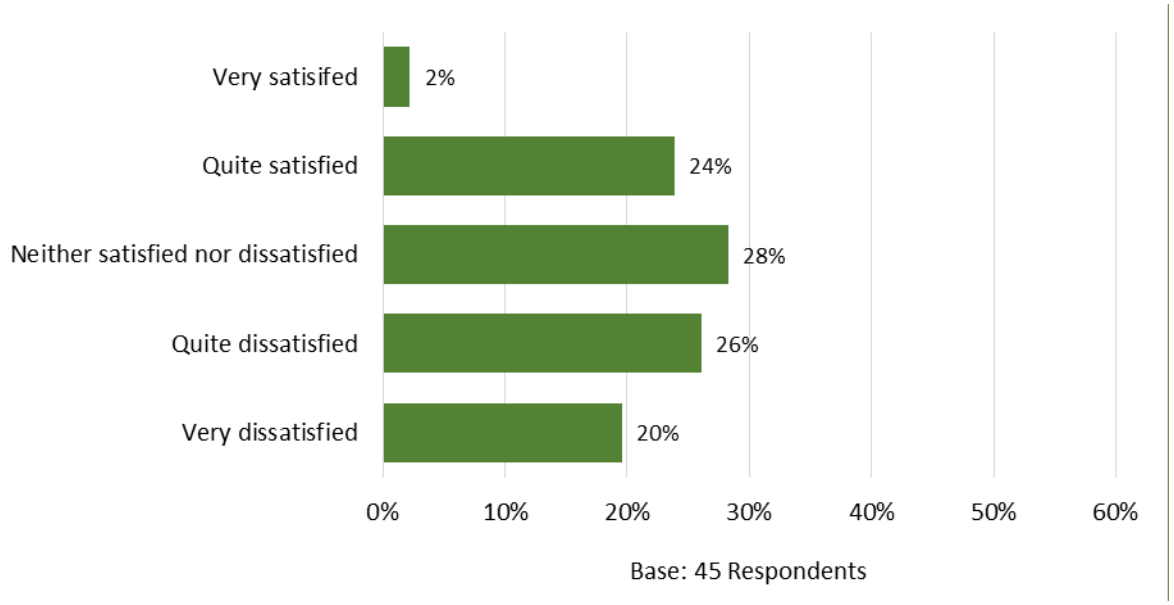
Just under two thirds (64%) of secondary schools are generally satisfied with their laboratory facilities although only 11% are 'very satisfied' (Figure 39).

Figure 39 Satisfaction with laboratory facilities



There are mixed views among secondary schools as to whether they have sufficient time to carry out effective preparation within laboratories for science practical work. Just under half (46%) are dissatisfied with the time available and a further 28% are undecided on this matter (Figure 40).

Figure 40 Satisfaction with laboratory preparation time



Schools were asked to indicate their ability to access specific laboratory facilities. The most needed items are summarised in Table 11 followed by the full results in Figures 41 and 42.

Table 11 Most needed laboratory facilities

Not easy to access but use	No access but need
A working fume cupboard which has access to gas, electricity and water Sufficient storage for all equipment in preparation rooms Access to blackout	A post-16, space to leave long term investigations/experiments Ducted fume cupboard in preparation rooms with access to gas, electricity and water Access to blackout

Figure 41 Access to laboratory facilities (Part 1)

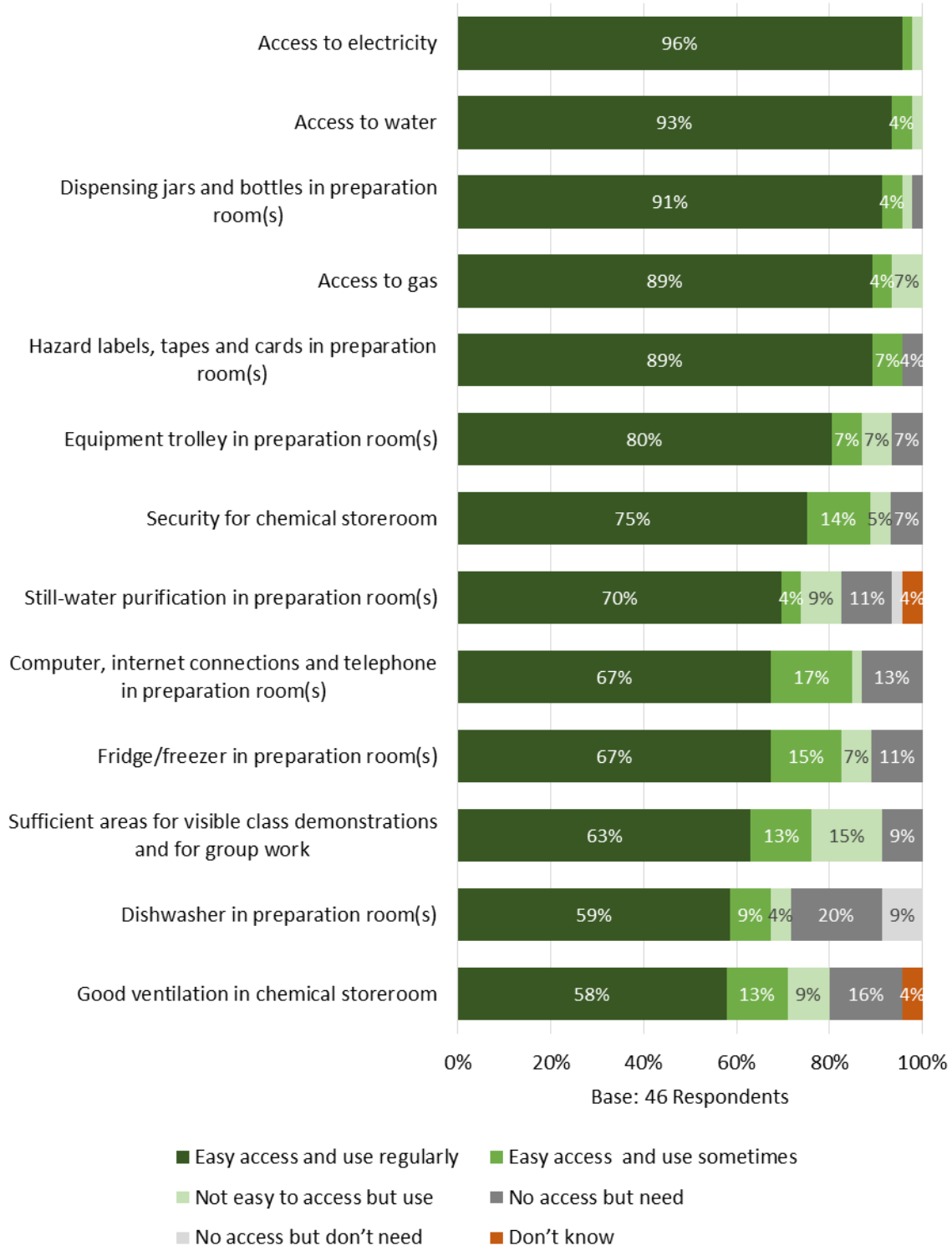
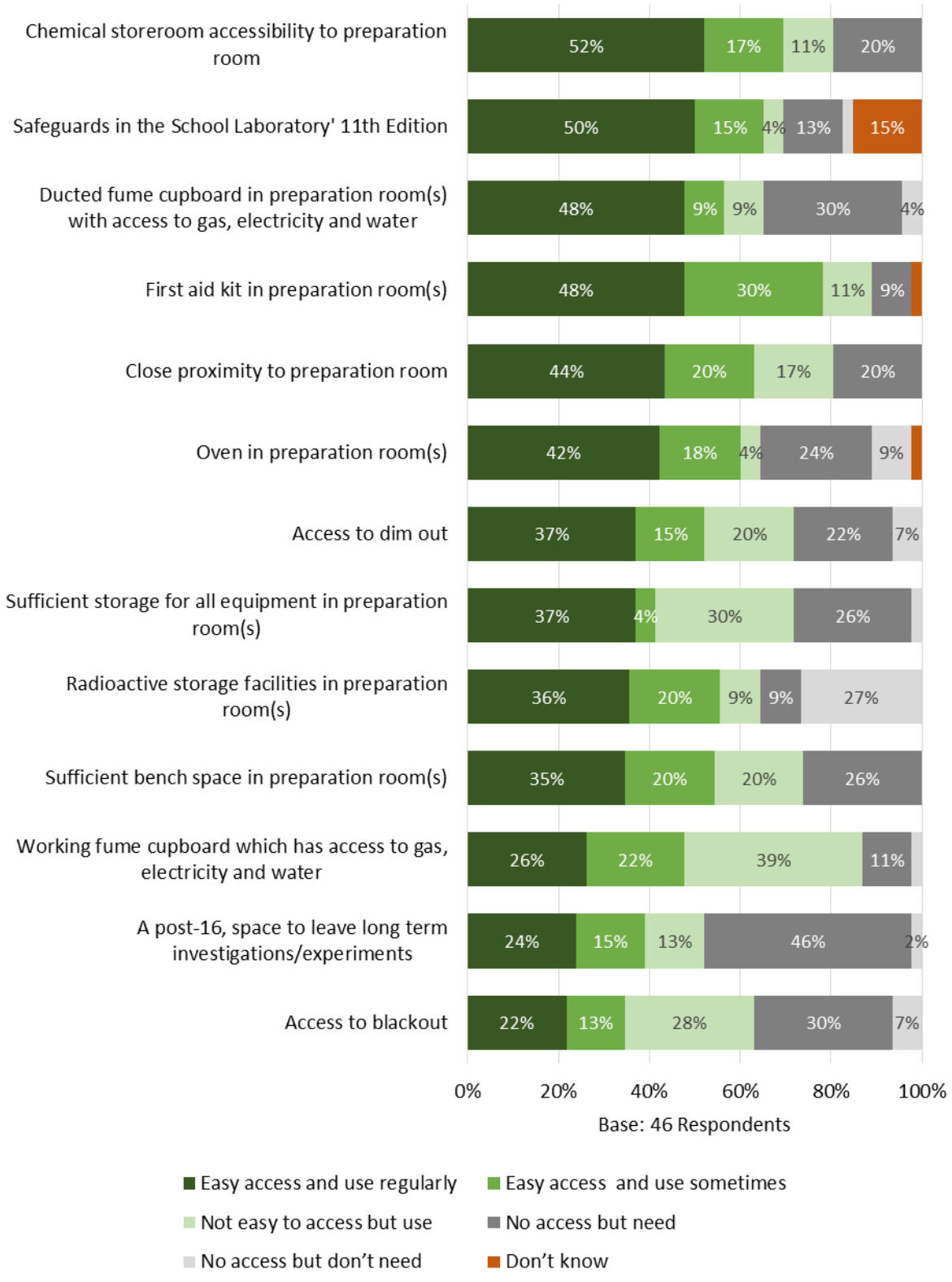


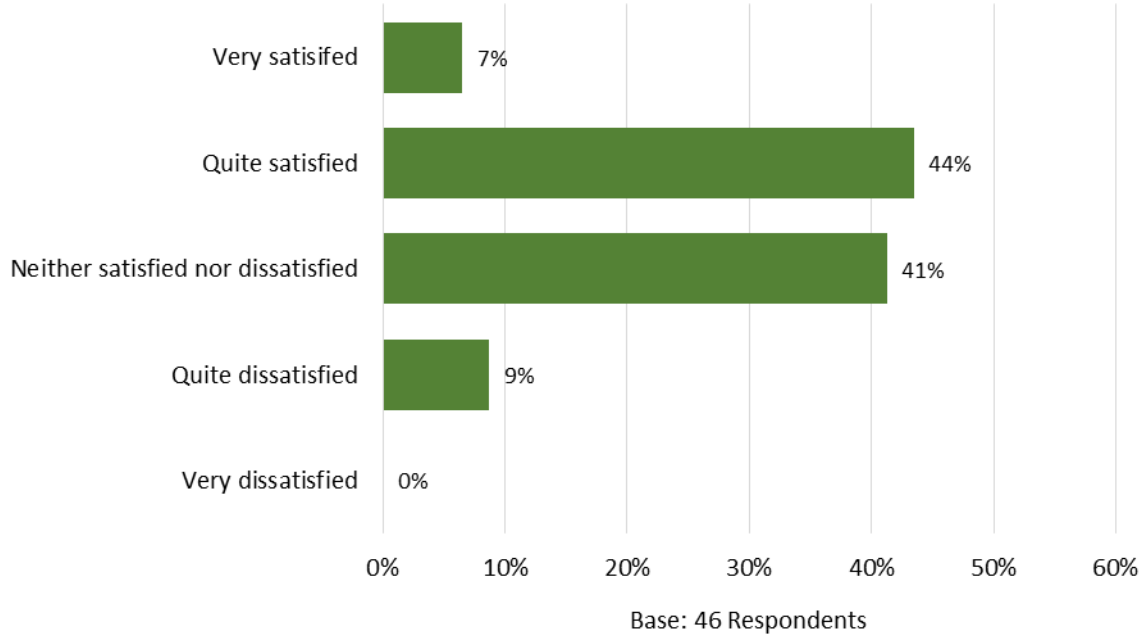
Figure 42 Access to laboratory facilities (Part 2)



3.6 Outside Learning Space

Half of schools (51%) are generally satisfied that the science department has sufficient access to outside space to be able to effectively deliver science practical work, although only 7% are 'very satisfied' (Figure 43)

Figure 43 Satisfaction with access to outside learning space



Secondary schools were asked to indicate their ability to access specific laboratory facilities for pre-16 and post-16 learning, respectively (Table 12, followed by Figures 44 and 45)

Table 12 Most needed outdoor space facilities

Level	Not easy to access but use	No access but need
Pre-16 learning space	A pond or other natural water habitat Trees/hedges	A functioning renewable energy resource Outside resource for demonstrating the different properties of rocks
Post-16 learning space	A research facility for spectroscopy Varied ecology and habitats	A research facility for gene technology A research facility (accelerator) to study particle and/or nuclear physics A medical physics department in a hospital

Figure 44 Access to outside learning space (Pre-16 learning)

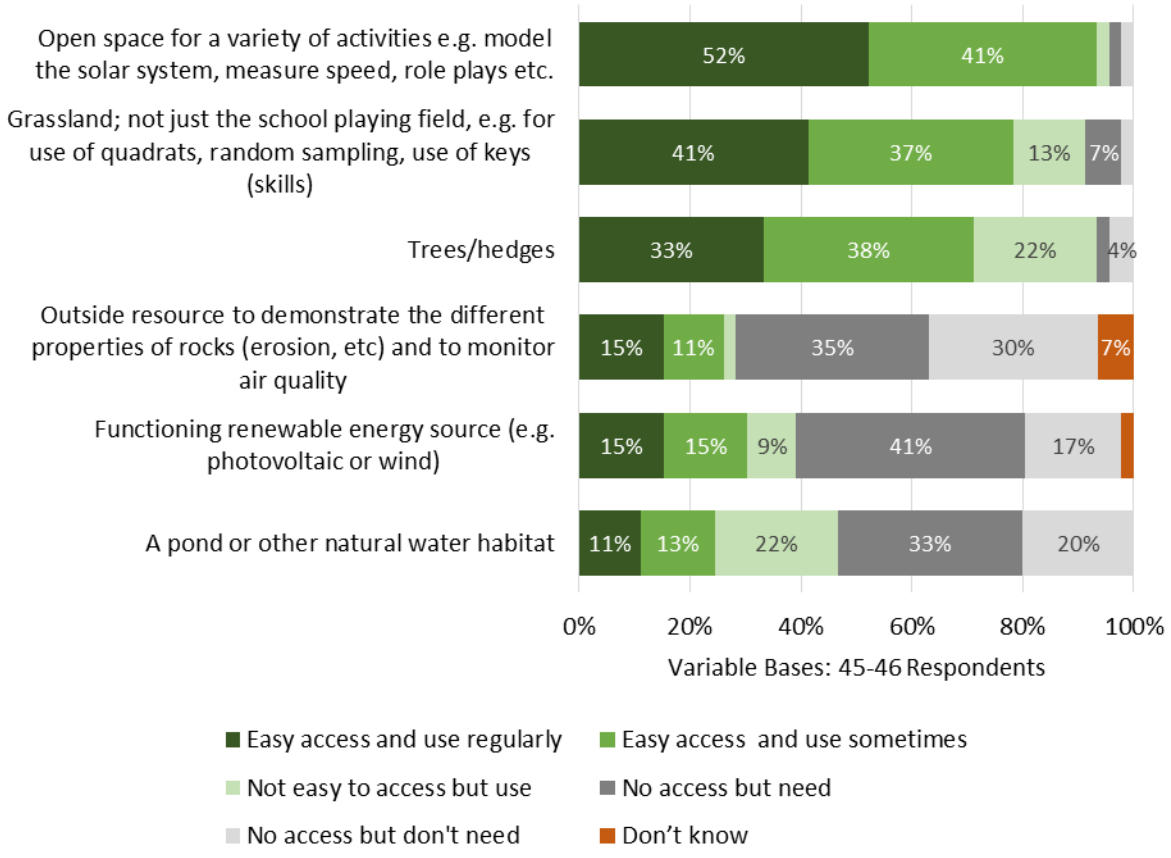
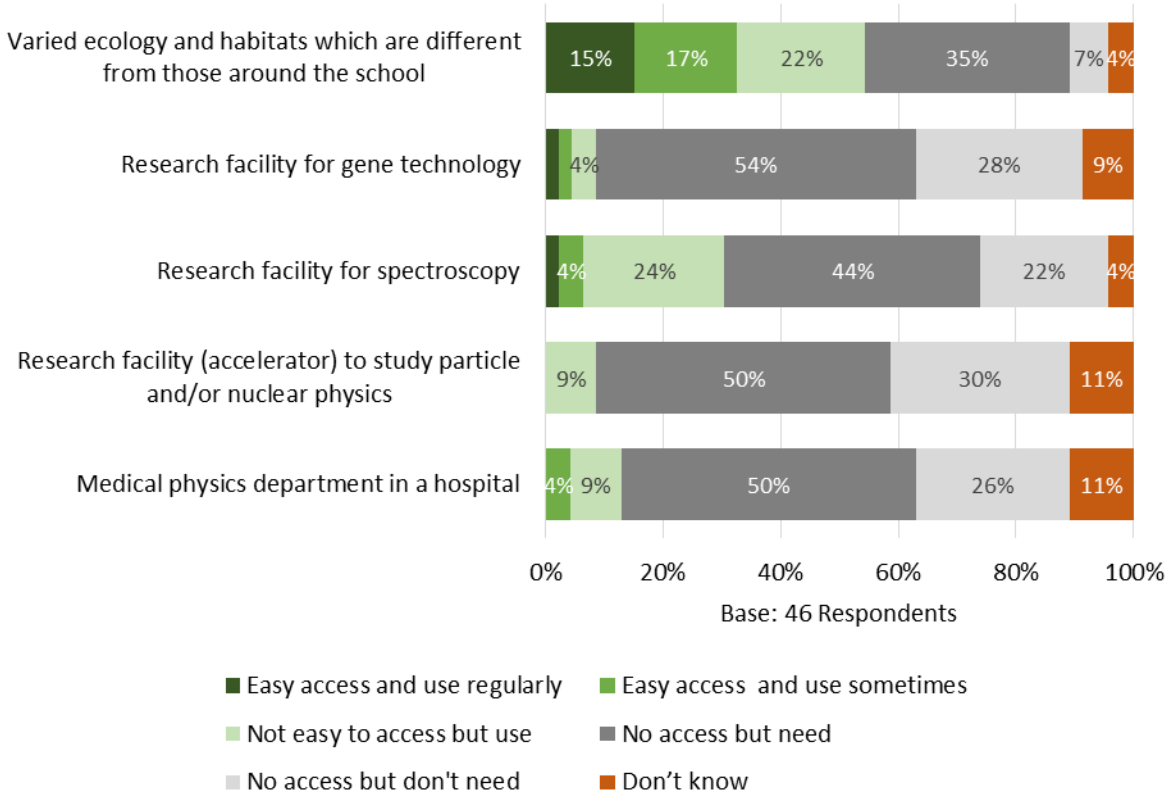


Figure 45 Access to outside learning space (Post-16 learning)



3.7 Barriers to Resourcing Practical Science

Almost all schools raised the issue of funding as a critical barrier to investing in new and innovative equipment, repairing or replacing old and outdated equipment, and covering the cost of associated staff training to ensure its effective use.

Budgetary constraints are a particular issue where curriculum changes place greater and more complex demands on students that cannot be easily met, particularly with respect to data logging equipment. In some cases, limited existing stocks of working items means students have to work in large groups where small groups would be more advantageous to participation and learning. Furthermore, excessive use of some items means they are more likely to need repairing or replacing sooner.

A small number of schools pointed out that the costs involved in carrying out science experiments are not fully understood by school management, local authorities and central Government, leaving the impression that science is not as high a priority as it is made out to be.

"Essentials such as stationery and reprographics take up a huge part of the budget, then it's annual consumables and replacing basics due to wear & tear. We never have funds within the budget to buy new innovative equipment or to fund trips."

"Lots of good experimental ideas from the likes of SSERC require large quantities of consumables and whilst we try very much to deliver practical based courses this is an enormous strain on budget."

"Budgets have been frozen and more is spent on paper based course materials over practical science."

A small number of schools raised concerns that limited or no technician support places great pressure on teachers and takes up valuable time for lesson preparation.

"The erosion of services such as the staffing ratio of technicians to pupils seriously threatens the delivery of practical science as teachers cannot teach and prepare experiments at the same time."

"We have whole school technicians, therefore no one is dedicated to science."

One school mentioned that the amount of content contained within the new N4 and N5 curriculum means that practical work suffers due to time constraints.

3.8 Improving the Resourcing of Practical Science

A variety of suggestions were received from secondary schools for improving practical science resourcing. While the majority of suggestions relate to increasing funding (some simply stated "we need more money"), these have been broken down below to unpick funding-related and non-funding related issues in more detail.

Funding-related suggestions for improvement:

- Recognition by funders that delivering high quality Science is expensive and that it should be taught in a practical investigative manner rather than relying on paper based resources;
- Recognition by funders of the increasing cost of equipment and consumables that can squeeze current budgets tightly;
- More dedicated central government investment, for example specific money should be made available at times of big change (e.g. major curriculum changes);
- Purchasing of large items per local authority - allowing schools to share expensive equipment;
- A bulk-buying system that would allow schools to club together to obtain better prices; and
- Allowing schools to procure equipment from publishers and suppliers not on the approved list, which could help to save money and allow schools to take advantage of competitive offers (for example universities that are refreshing their stock).

Non funding-related suggestions:

- A set list of the minimum resources needed to teach science;
- Better time planning, as risk-assessing and carrying-out practical work can be particularly time consuming; and
- Better staff training (CPD) on the effective use of equipment, with particular focus on exposing student teachers to relevant practical work which is being carried out in Scottish schools.

4. Conclusions and Recommendations

4.1 Conclusions

The survey findings indicate that science resourcing levels in primary and secondary schools in Scotland might be insufficient to fully and effectively meet the requirements of the curriculum. The issue does not simply relate to the apparent poor state of equipment and consumables but also disparities between schools in terms of how budgets are allocated, the amount of classroom and technician support, teacher confidence and access to additional funding such as grants.

The amount of money that each school allocates to science appears to be dictated by a range of competing priorities. This could well explain the variation in forecasts given for whether science spend is likely to increase or decrease over the next 12 months. Secondary schools are generally less satisfied than primary schools with the amount of funding allocated to science practical work (44% of primary schools are dissatisfied compared to 80% of secondary schools) with one explanation likely to be that primary school class teachers are responsible for multiple aspects of the curriculum.

Within secondary schools, the science budget appears to be stretched particularly thin, with the cost of reprographics eating into more than a third (38%) of total science spend, compared with just 2% in primary schools. Furthermore, the cost of consumables, including replacement of old and damaged equipment (some of which is reported to be 30-40 years old) seems to be taking place at the expense of investments in new and innovative equipment.

Secondary schools in particular are concerned that changes to the curriculum require ever more sophisticated and up-to-date resources (particularly data-loggers) but current funding levels are prohibitive, resulting in these tools having to be shared among large numbers of students and between classes, to the possible detriment of learning.

A further indicator that funding levels for practical science are insufficient is that the vast majority (98%) of both primary and secondary schools draw on additional and alternative sources of funding for normal and extra-curricular practical activities. Parental contributions are the most common source among primary schools for extra-curricular activities, and staff contributions the most common among secondary schools for normal-curricular activities.

Existing procurement arrangements and the use of approved suppliers also appears to restrict schools from securing maximum value for money and there is a desire to be able to source and obtain equipment and consumables elsewhere.

Finally, teachers appear to lack confidence in the use of certain types of equipment due to a

combination of insufficient training and lack of exposure and experience. Time pressures are also a factor that can influence whether teachers are able to prepare for practical sessions, particularly in secondary schools where there is limited or no dedicated technician support.

4.2 Recommendations

The following recommendations are intended to provide a starting point for the LSG to raise awareness about science resourcing issues in Scottish schools and work towards the provision of better overall arrangements through both funding and non-funding related improvements.

1. Work with partners to further raise the profile of the science curriculum to the Scottish Government and local authorities – particularly the importance of practical science activities and the role that equipment, consumable and spatial resources play in meeting curriculum requirements;

2. Consider developing a case to lobby for more science funding, with the main arguments being:

    a. Scottish Government's strong focus on science;

    b. Curriculum changes that justify additional equipment spend;

    c. The age and condition of existing equipment and consumables in some schools;

    d. Insufficient or even no access to certain types of practical science equipment in some schools; and

    e. Insufficient or even no access to science technician support in some secondary schools.

3. Develop an equipment resource list that is aligned to Scottish curriculum needs and better enable schools to work together to share resources (particularly expensive equipment) or club together to make larger group purchases for a potentially lower price;

4. Provide more information and guidance to schools on the types of grants that may be available to support science equipment spend;

5. Explore and disseminate examples of good practice within certain schools in areas such as:

    a. Identifying how costs can be saved in non-essential areas and with a view to boosting spend on equipment and consumables; and

    b. Improving teachers' time management where this could act as a barrier to preparing for and

delivering practical science sessions.

6. Research and disseminate the ways in which practical science can be taught and supported through greater use of IT facilities and online resources;

7. Consider developing a case for more high quality training and CPD for science teachers to improve knowledge and expertise in relation to the effective use of practical equipment;

8. Consider developing a case to relax the use of approved supplier lists where schools could procure equipment and consumables for a better price elsewhere; and

9. Continue to raise awareness among primary schools in particular of the services and resources which they can access from the Scottish Schools Education Research Centre (SSERC).