The Student Review of the Science Curriculum

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Brief description of article

This paper describes the process and presents some of the main findings of a student-led review of the science curriculum in England, a project conducted as part of Science Year.

Abstract

This paper presents some of the main findings of a student-led review of the science curriculum in England. Over 350 students, aged 16-19, designed possible questions for a web-based questionnaire at regional meetings held across England. In the six weeks to 8th February 2002, a total of 1,493 questionnaires were submitted. Analysis of these responses shows considerable student dissatisfaction with the science curriculum. A list of 10 student recommendations is provided.

Key words

Curriculum, attitude, gender

Word count (including abstract and references)

4986

The origins of the review

The Student Review of the Science Curriculum arose out of a proposal from The Science Museum in London to celebrate Science Year (2001-02) by involving students in a novel consultation on school science education. From an early stage it was agreed that the Student Review would be conducted by 16-19 year-olds who had completed their GCSEs the preceding summer (most of whom would therefore be 16-17 year-olds). It would be a web-based questionnaire targeted at KS4 and 16-19 year-old students. It would be designed by students who would include both science and non-science students.

The notion that young people might be responsible for carrying out a consultation exercise on a subject that concerns them hardly seems radical. And yet, young people are all too rarely consulted let alone allowed to design such processes. In cases where young people have been consulted about their views of the science curriculum, it has invariably been found that they are highly articulate, insightful, take the process seriously and produce valuable findings (e.g. Osborne and Collins, 2000; Reiss, 2000).

A number of studies have explored ways of consulting with young people (e.g. Driskell, 2001). We are, though, unaware of any previous exercise in which young people have designed and implemented a web-based questionnaire study such as this.

Obtaining the data

Students were in control of the review process at every stage, including a series of nine regional meetings which identified contentious issues in the science curriculum, the development of an on-line survey of 55 questions, a national conference at which the interim findings were presented to an audience which included Baroness Ashton and the production of the final reports. Students also helped select the quotations given in this paper and drafted the ten recommendations with which we conclude.

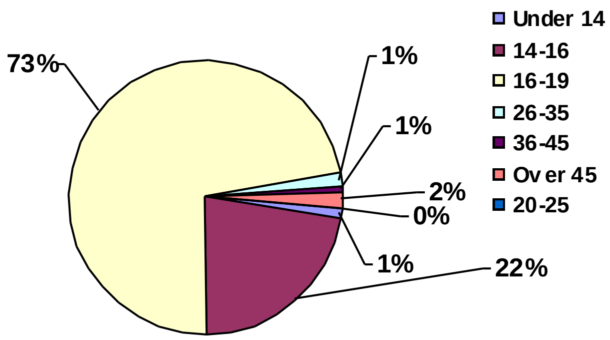
Over 350 students, aged 16-19, designed possible questions for a web-based questionnaire at regional meetings held across England. About two-thirds of those at the regional meetings were female and about two-thirds were studying science post-16. The meetings had an average of around 35 students. A selection of these students made up a national group that was responsible for the final design of the questionnaire and for helping to analyse and report the interim findings. A further group of students helped complete the analyses and production of the final reports. The questionnaire and reports of the process and the findings can be viewed at www.planet-science.com/sciteach/review

This paper and the reports are based on the replies that were submitted between just before Christmas 2001, when the online survey went live, and 8th February 2002. In these six weeks, a total of 1,493 questionnaires were submitted, with a conversion rate from hits of about 45%, which is extremely high for web-based surveys (Hewson *et al*, 2003). Most of the submitted questionnaires contained answers to the great majority of questions. However, not all respondents answered all questions. For this reason, sample sizes differ from question to question and are indicated by the ‘n’ values below.

The nature of the respondents

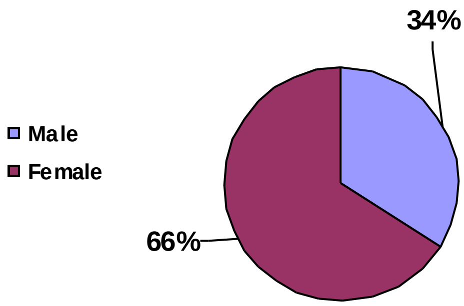
The breakdown of those who submitted questionnaires by age and gender is shown below.

(n=1,479)



Breakdown of respondents by age

(n=1,467)

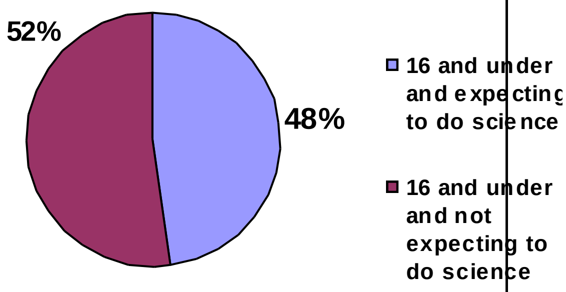


Breakdown of respondents by gender

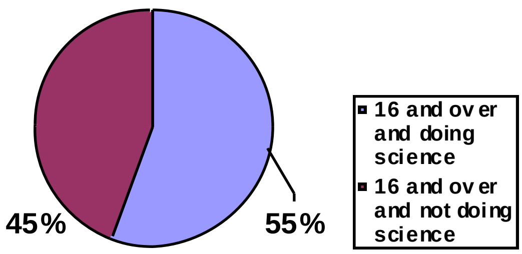
As can be seen, the great majority of respondents were in the main target 16-19 age group. Just under a quarter were in the next age group targeted by the survey – the 14-16 year-olds. Breaking down the results by respondent age showed that this rarely had any effect on the responses given. However, gender did sometimes correlate with responses and for this reason certain results below are reported by gender.

As the two following pie charts show, nearly half of the respondents were not science students or, for students who hadn't completed their GCSEs, did not expect to be science students. This shows that the review process reached a broad cross-section of students.

(n=329) (n=1,077)



16 year- olds and under and science expectations



16 year-olds and over studying science

It is important to note that 64% of declared respondents were from private schools. This is very different from the national picture where private schools account for only 7% of 11–16 year-olds and 20% of sixth formers. Additionally, only 53% of respondents were in mixed schools (nationally, the figure is 88%) with 41% in all-girls schools (nationally, the figure is 7%) and 6% in all-boys schools (nationally, the figure is 5%). All figures are for 2002 and from the DfES.

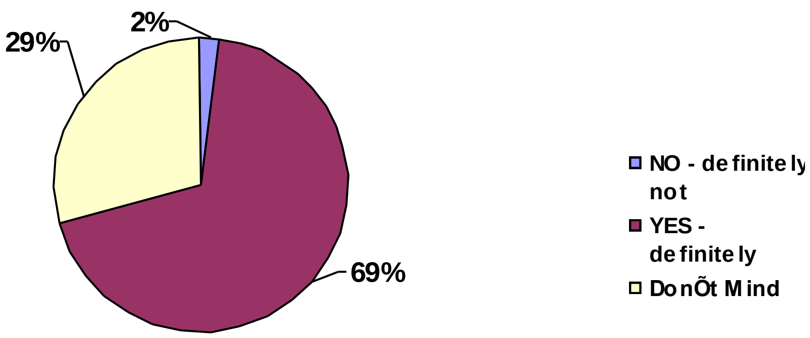
These patterns were not intended, reflect the greater difficulties in attracting involvement from the state sector (excepting sixth form colleges) and from mixed schools and mean that the quantitative results reported her are not representative of English schools generally. Only 60% of respondents declared whether their school was state or private. No attempt has been made to 'normalise' the data reported below; all figures refer directly to the actual data obtained.

The content of school science

What topics should be included?

Whether school science should include controversial issues and, if so, how these should be taught is still a matter of debate among science educators (Levinson and Turner, 2001). However, it was very clear from the responses to question 12 on the survey 'Is it right to include CONTROVERSIAL issues such as genetic engineering or cloning in the science syllabus?' and from the regional meetings that students feel that the answer is ‘yes’. Indeed, it is notable that only 2% of survey replies said that controversial issues should definitely not be in the science syllabus. This conclusion held up equally strongly in state schools (1% saying ‘no’) and in private schools (2% saying ‘no’).

(n=1,471)



Should controversial issues be included in science?

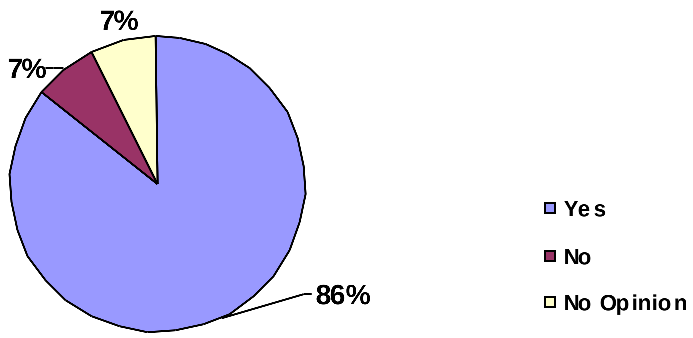
Students were asked ‘What do you think about the amount of facts you have to learn in science?’ (question 44). The answers to this question flooded in and a representative sample were picked out by the students:

- Too many facts have to be learnt without a full explanation of them.
- There are more facts than theory, it would be more interesting to understand why than how.

- I think that the GCSE is not geared to rewarding those who can understand and apply scientific knowledge but just to those who are able to remember the most facts.
- They are generally useful and are quite relevant but they are very exam based.
- Far too many irrelevant facts that I have now forgotten, in fact I forgot them about a week later, need to focus more on applying facts to situations so that they will be useful in real life and for the coming years.
- There are too many. To get a good grade you do not have to be a good scientist – just have a good memory.
- The facts are made easier to learn if they are applied to each other. The facts are necessary to move on to higher level science.
- I think that there is an awful lot to remember for the final exam which deters students from actually understanding science as they just aim to learn the syllabus off by heart.
- There is too much emphasis on rote learning – I think we should be asked our own views more.

Dissection produced a hot debate at some of the regional meetings – some students wanted to do it in their schools and it was forbidden; others loathed dissection but said they had had to do it. In the end the students agreed simply to ask of each other 'Should you be given the choice to do dissection in biology?' (question 15). The answer was clear.

(n=1,469)



Should students be given the choice to do dissection?

While a strict use of the term ‘dissection’ would include plant dissection, there is little doubt that animal dissection was meant here. Arguments for and against animal dissection in schools are reviewed by Lock and Reiss (1996). Here it is clear that what students definitely wanted was the option to choose whether or not to do dissection. This was notably the case for females, 88% of whom voted ‘yes’ as opposed to 80% of males.

The teaching of school science

Students’ textual comments

When students were asked ‘Do you feel that what you learn is exam-led?’ (question 4), 85% said ‘yes’ and only 15% said ‘no’. There was little difference (just 3%) between state and private schools. When prompted by the questionnaire to comment further, students wrote about both the syllabus and how they would like to be taught:

- Smaller syllabus but with more detail into fewer topics.
- I think students will relate more to science if they understand how things work or are explained in everyday life.
- Being asked to put forward our own theories instead of just being told what was right.
- Varied and interactive lessons.

- Though smaller class sizes help, being taught in an enthusiastic manner works best.

Effective ways of learning

The students asked 'Which THREE of these methods of teaching and learning do you find the MOST USEFUL and EFFECTIVE in helping understand your school science?' (question 10), immediately followed by 'Which THREE of these methods of teaching and learning do you find the MOST ENJOYABLE as part of your school science?' (question 11). In each case, the same 11 possibilities were provided. Respondents were clear that what they most enjoyed wasn't always what was most useful and effective.

(n=1,450)

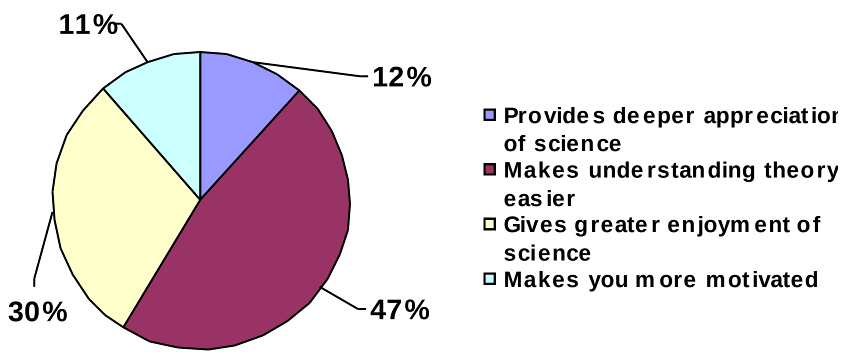
WAYS OF LEARNING	USEFUL AND EFFECTIVE (%)	ENJOYABLE (%)
Taking notes from the teacher	45%	15%
Looking at videos	27%	75%
Reading the textbooks	17%	18%
Taking my own notes from books etc.	24%	13%
Copying notes from the board	23%	17%
Doing a science investigation	32%	50%
Making a science presentation in class	17%	43%
Researching science on the Internet	8%	44%
Going on a science trip or excursion	30%	85%
Doing a science experiment in class	38%	71%
Having a discussion / debate in class	48%	64%

Students felt that while the three most enjoyable teaching and learning methods were (i) going on a science trip or excursion,

(ii) looking at videos and (iii) doing a science experiment in class, the three most useful and effective teaching and learning methods were (i) having a discussion / debate in class, (ii) taking notes from the teacher, and (iii) doing a science experiment in class. The two methods that scored highly on both questions were having class discussions / debates and doing science experiments in class. It is interesting to note that by far the least effective method was identified as researching science on the Internet. This finding is important because government policies have been directing students towards online learning for a number of years (Frost, 1998), yet students are obviously not finding it effective at the moment.

It is clear that students enjoy doing practical work and find it an effective way of learning, as other researchers have found (e.g. Osborne & Collins, 2000; Reiss, 2000). When respondents were asked 'If the practical content of the course was increased, how would it MOST improve the learning experience?' (question 27), the most widely cited answer of the four options was that it would make it easier to *understand* theory.

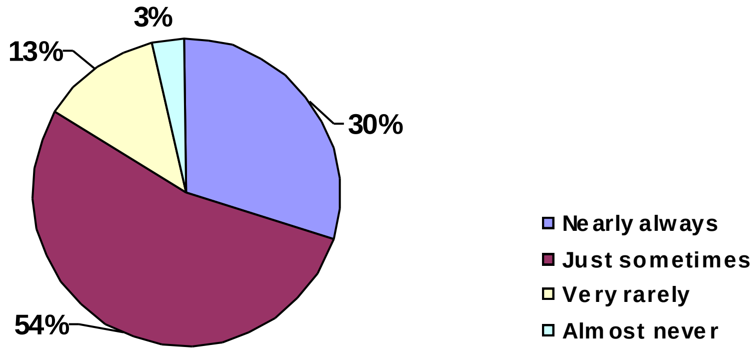
(n=1,451)



How practical work helps

However, when they were asked 'Currently (or when you did your GCSEs), when you learn new theory is it backed up by practical experiments?' (question 28), the most frequent response was 'Just sometimes'.

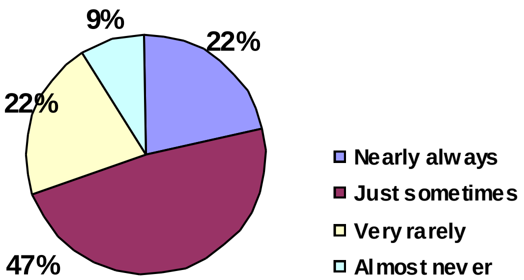
(n=1,460)



Is/was your GCSE science theory backed up by practical experiments?

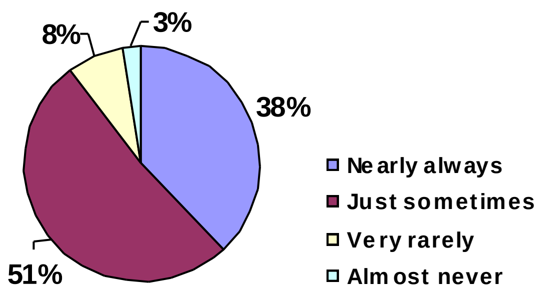
Breaking down these replies by triple, double and single award science shows that it is single award science students who get the least practical work.

(n=78)



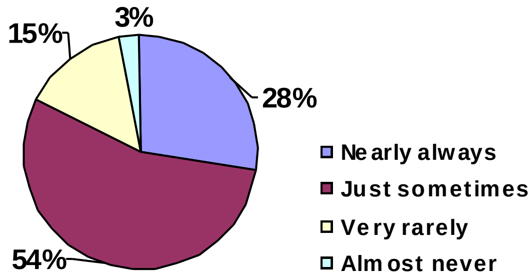
Single award doing practicals

(n=344)



Triple award doing practicals

(n=989)



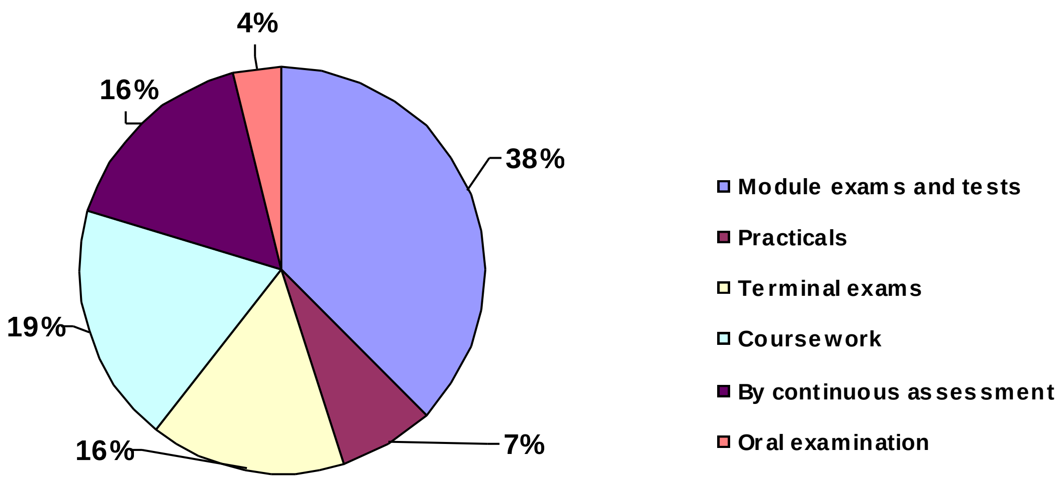
Double award doing practicals

Overall, just 11% of the triple award students reported very rarely or never having practicals. However, this figure grew to 18% of the double award students and 31% of the single award students.

Modes of assessment

The students also asked of each other ‘How do you MOST prefer to be assessed / examined in science’ (question 8) and the replies are perhaps interesting in their 'conventionality'. The students did not seek any major change in the modes of assessment. It can be seen that module exams and tests get the largest endorsement. In the light of the views reported earlier about practical work, it is noteworthy how small the proportion of students is that would wish to have practical-based assessments.

(n=1,475)



How do you prefer to be assessed?

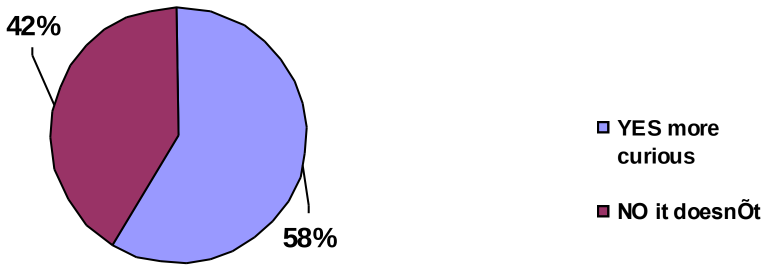
In the regional meetings, students frequently reported on the pressure to get the right results in practicals for GCSE coursework. Indeed, students frequently described how their own implausible or wrong practical results were substituted by the teacher's 'better' results. This is a far cry from what investigative work in school science is meant to consist of (Watson and Wood-Robinson, 1998). It may be these experiences which make students wary of extending assessment further into practical work, and more research would probably clarify these points.

GCSE science

Attitudes to science

A number of the questions in the survey focused specifically on GCSE science. One question asked ‘Do you feel that GCSE science lessons make you curious about the world and interested in finding out more?’ (question 51). Rather dishearteningly, 42% felt that GCSE science does not encourage curiosity.

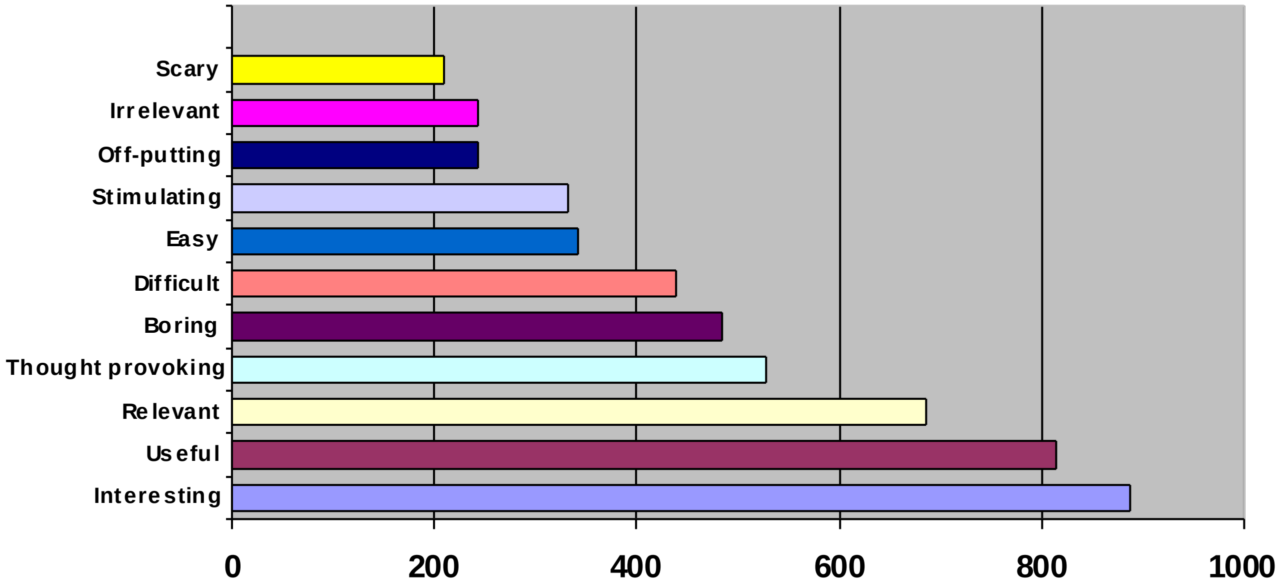
(n=1,434)



Does GCSE science make you curious about the world?

Among students taking double award science, nationally by far the most frequently taken form of GCSE, the figure was 57%.

There have been many academic studies on students' attitudes to science (e.g. Osborne *et al*., 1998) though such studies don't tend to suggest the wonderful range of adjectives that the students came up with in their possible responses to 'Do you find GCSE science? [tick all that apply]' (question 50). It is extremely encouraging to note that the most frequently used of the 11 adjectives was 'interesting', followed by 'useful', 'relevant' and 'thought provoking'. It is important to keep this in mind when considering the criticisms the students make of GCSE science.



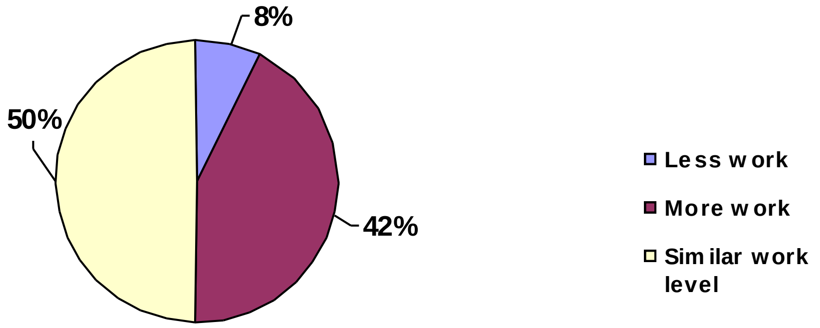
Attitudes towards science

Comparing the responses to this question with those to the question that asked whether or not GCSE science encouraged curiosity suggests internal validity. For instance, the most frequent adjective used to describe GCSE science by students who wrote that GCSE science does not encourage curiosity was 'boring'.

GCSE science workloads

When students asked 'Do you think the workload in your GCSE sciences is less than, similar or more than other subjects?' (question 49), it was clear that the workload in science is felt to be either similar to or more than that in other subjects.

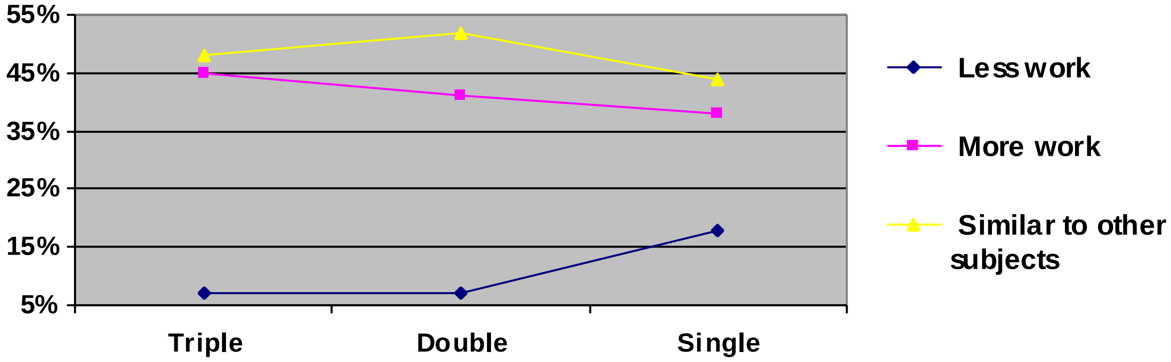
(n=1,440)



The workload of GCSE science compared to other subjects

Perhaps unsurprisingly, those doing triple award science are most likely to find the workload heavier than in other subjects. Indeed, there is anecdotal evidence that in many schools, triple award science receives proportionately less lesson time than double award does.

(n=1,401)

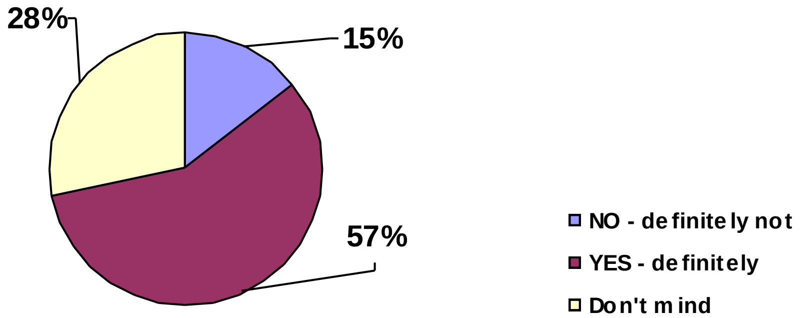


Perceived workload compared by study award

Ethics and science

When it came to whether philosophy and ethics should be taught in GCSE science, students were clear. Asked 'Do you think the introduction of discussions about philosophy and ethics (such as animal testing) would make GCSE science more attractive as a subject?' (question 14), most answered 'yes'. However, it is noticeable that the demand for philosophy and ethics in GCSE science is not as strong, as discussed above, as the demand for controversial issues in science generally (cf. Donnelly, 2002).

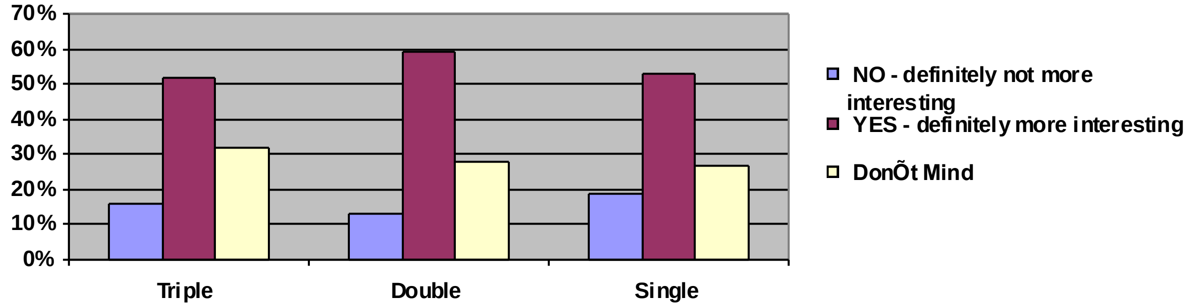
(n=1,467)



Would discussions about philosophy and ethics make GCSE science more attractive?

Interestingly, this request for more philosophy and ethics held up pretty evenly across triple, double and single award science.

(n=1,414)



Would discussions about philosophy and ethics make GCSE science more attractive?

The results seem to indicate that students at all levels have a desire to understand and explore the moral issues of science as part of their courses.

This question produced one of the few gender differences on the survey. 61% of females answered ‘yes’ and 11% ‘no’, whereas only 49% of males answered ‘yes’ and 21% answered ‘no’. It is well known that males, especially adolescent males, are more likely to favour objective certainty than females, who are more likely to favour discussions (e.g. Head, 1997).

Textual comments on GCSE science

When asked ‘What topic do you find MOST interesting in GCSE science?’ (question 54), biology topics were by far the most frequently mentioned, followed by physics, with chemistry third, for reasons which students were often happy to volunteer:

- Biology – because this is to do with everyday life and your body, and the things that happen around you.
- Human biology because I can relate to what I’m learning.
- Biology, the brain. I love to find out how and why we think of things and what the other part of our brain is used for.
- Animal Biology – the human side, learning how the body works and dissecting hearts and lungs. The plant side was also fascinating.
- How the human body works and regulatory systems in it ………….. oh and, dissecting a human heart in Human body *(sic)* – useful & interesting.
- Cloning – that’s all I can remember, which must mean I enjoyed it.

- About the human body and brain it is interesting to find out how the body works, and chemistry is interesting with all the experiments and learning about bonding and structures of atoms etc.
- Many physics topics, relating to everyday life, ‘pressure’ for example.
- Physics – radioactivity, it was new and different from a lot of the other topics on the syllabus.

When asked ‘What topic do you find MOST irrelevant or boring in GCSE science?’ (question 53), physics topics were mentioned the most often, followed by chemistry, with biology topics the least. To give just a few quotes:

- I don’t really care how you work out how fast a ball falls if it weighs 10 kg and is falling 4 metres, it’s not stimulating and I’m never going to use that information again.
- Physics. I have never, nor will I ever, either see the point in or understand physics. It always seemed pointless spending hours of experimental time proving what was already proven, or that black wasn’t a colour, or whatever.
- Equations in bonding (chemistry) – for a person who KNOWS that she will not ever go into chemistry, that was pointless, difficult to grasp, and boring.
- Chemistry – learning how chemicals are used in industry is very boring – chemicals in the body and used in drugs are more interesting and relevant.

This question proved one of the most popular ones on the survey. There was a big gender difference. Amongst the males, there was only a 3% variation between biology, chemistry and physics. However, females were over three times as likely to mention physics topics as biology ones, and more than twice as likely to identify physics topics than chemistry ones. It is well established that girls are more likely than boys to criticise school physics as being impersonal and detached from daily life (Vlaeminke *et al.*, 1997).

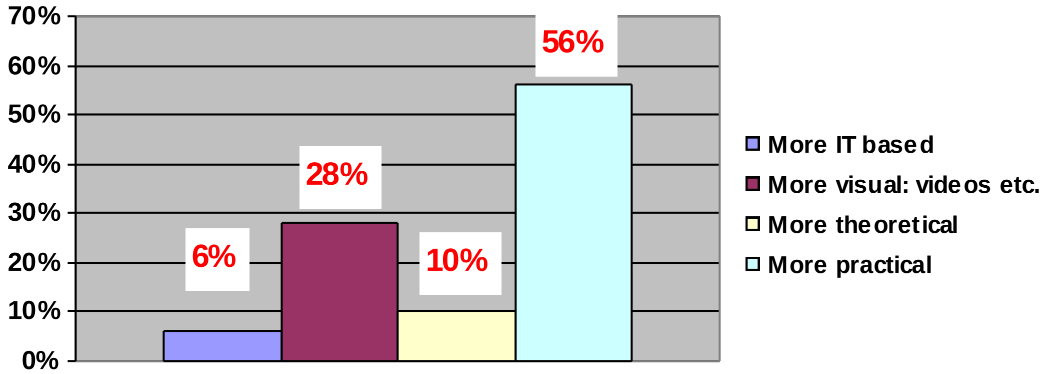
Primary science

Question 29 asked: At primary school should science?

Be more practical	O
Have more theory	O
Be more visual (videos etc.)	O
Be more IT based	O

The interesting point shown by the responses is not just the rejection of Information Technology but also the belief of the students that they must see what is going on in science – either actually in practice or at least in something like a video. The Primary Assessment, Curriculum and Experience (PACE) project which ran from 1989 to 1997 found that Year 6 pupils were particularly critical of the amount of time they had to spend writing in science (Pollard *et al.*, 2000).

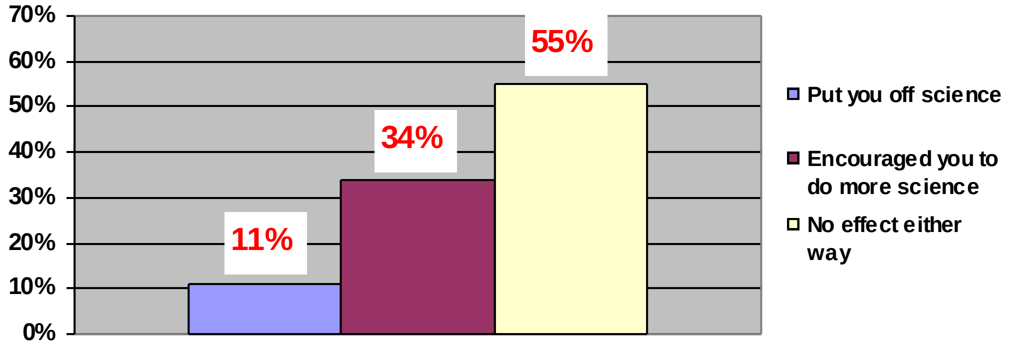
(n=1,464)



How should primary school science have been different?

Question 30 asked:	At primary school did science?	
	Put you off science	O
	Encourage you to do more science	O
	Not influence you either way	O

The results were moderately encouraging.



How did primary school science affect you later?

Primary school science only had a negative impact on 11% of students while 34% were encouraged by their primary science experiences to do more science. However, the students also asked of each other 'In GCSE science, did/do you understand the majority of information?' and 22% of the minority who felt that they did not understand the majority of GCSE science information felt that they had been put off science at primary school. This proportion is exactly twice that of the sample as a whole and bears witness to the importance of good primary science experiences (see Sherrington, 1998; Galton, 2002).

Closer analysis of the data suggests that a strong negative or positive primary science experience carries through for the next six or seven years. These results can be interpreted alongside a widespread belief that primary science education has been one of the success stories of the National Curriculum in England and Wales as measured by both teacher confidence

(Bennett *et al*., 1992) and international comparisons (Harris *et al*., 1997). At the same time, it is important to note, first that the primary science curriculum has changed considerably since the 14-19 year-olds in this survey were in school, and secondly that what is reported here is people's interpretations of events that happened years previously.

When asked 'If something was missing from your primary science, what was it?', quite a variety of responses were produced, including some that talked about curriculum pressures on science and some that talked about a shortage of experiments:

- Science wasn't our main focus, we mostly focused upon English and Maths.
- The lack of facilities made experiments and visual aids difficult and therefore I didn't really experience science as a subject until secondary school. The primary years are the ones in which I think you should be motivated to continue.
- We barely did any, due to people talking and the teacher having to cope with them before teaching us.
- Fun experiments to hold the child's attention.

The importance of primary science was summed up thus by one of the students involved in the production of the final reports:

- From my experience with primary science I know for a fact it is a lot easier to grasp concepts at an earlier age and then move on to the complicated things in secondary science, after all at a young age you are excited to learn something new and as you get older you like to know you understand something in great detail.

Student recommendations

1. *Ethical and controversial issues*

   The science curriculum should include more ethical and controversial issues. These should not be hived off into occasional discrete topics but included throughout the curriculum.

2. *Practical work*

   Practical work should be strongly encouraged and relevant to the syllabus. The practicals need to be supervised, they need to work and they need up-to-date equipment.

3. *Dissection*

   Schools should provide students with the opportunity to do dissection but individual students should have the choice as to whether or not they do dissection.

4. *Science and maths*

   The fundamentals of maths should be covered in maths lessons but science lessons should explicitly include a coherent treatment of the maths needed for science. Better communication is needed between science and maths teachers.

5. *Science teachers*

   Good science teachers are crucial. Science teachers should be qualified to teach science and should have the appropriate subject specialism within science, if possible.

6. *Slimming the curriculum*

   The science curriculum should cover fewer topics to allow for more in-depth treatment and for more detailed explanations.

7. *Discussions in science*

   There should be more discussions in science classes. Discussions provide students with the opportunity to learn from someone other than their teacher and, healthily, to disagree with teachers and develop their own ideas.

8. *Good science teaching*

Learning is helped by having a teacher who can engage with students and by the use of visually stimulating material.

9. *Making chemistry and physics more popular*

   The popularity of chemistry and physics would be raised if they connected more with real-life situations, as biology does, and included more ethical issues.

10. *Primary science*

    In primary school, integration between science and other subjects is important. Primary science should be placed at the same level of importance as English and maths. Better equipment is needed for primary science teaching.

Conclusions

This is the first time that such a student-led review of the science curriculum has taken place. The findings of the review were reported by a number of national newspapers and on television. While such news stories have a short shelf-life they gave the students involved in the project a sense of having participated in something of significance and value. Most of the national group were also interviewed by their local papers which brought appropriate publicity to their own schools and colleges.

One piece of good fortune came from the fact that the Parliamentary Select Committee on Science and Technology started a review of KS4 science at just the time that the Student Review data were being analysed. The Select Committee was able for the first time formally to take evidence from this age group which it did at the Science Museum itself (see House of Commons Science and Technology Committee, 2002). The Select Committee was delighted, the students were delighted and those funding the Student Review were delighted. All the oral evidence given by the students to the Select Committee was listed, and Volume One of the report was thick with quotations from them.

The results of the review argue that there is a need for the science curriculum to change. Currently school science fails to convey the extent to which science is related to everyday life and affects all of us. Space needs to be made to allow controversial issues to be included and to allow topics to be studied in more depth. A system needs to be put in place to ensure that decisions that affect students cannot be taken without taking students' views into account.

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