

The ROSE Survey in Scotland - An Extension Survey of Younger Pupils

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By

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Authors' Foreword

A year ago we reported findings from a relatively large scale study, applying the international Relevance of Science Education Survey (ROSE) with nearly 3000 Secondary 3 pupils in Scotland. This Report provides an account of some complementary follow-up work, on a smaller scale and with an abbreviated survey, with Primary School Pupils who have visited one of the Four Scottish Science Centres. This has been done with the help and advice of the Science Centres and was designed primarily to help inform their own strategies in promoting young people's interest in science. It has also involved some further analysis of the data from the S3 survey.

This work has been funded by the Scottish Executive Enterprise, Transport & Lifelong Learning Department. The project has been undertaken by STEM-ED Scotland, a partnership organisation aiming to champion the development of world class educational provision in Scotland across the STEM disciplines (science, technology, engineering and mathematics). The team members are:

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We would like in particular to pay tribute to all who assisted in the implementation of our questionnaire from staff at the four Science Centres who helped in the adaptation and layout of the questionnaire and the primary school teachers who distributed the questionnaire forms.

Finally we would like to thank the primary school pupils for their efforts in completing this survey. We hope that the results will help inform the planning and design of future exhibits at the science centres and curriculum review more generally.

CONTENTS

Acknowledgements	2
Brief Overview	5
Main Conclusions	5
1. Introduction	8
1.1 CONTEXT	8
1.2 THE ROSE QUESTIONNAIRE	8
1.3 MODIFIED VERSION OF THE ROSE QUESTIONNAIRE	8
1.4 PILOTING THE MODIFIED SURVEY	10
2. Nature and Distribution of the survey sample	10
2.1 THE TARGET PUPIL POPULATION	10
2.2 SAMPLE CHARACTERISTICS	11
3. Validation and Processing of Returns.....	12
4. Interpreting the Likert Scoring System	12
5. Global responses on Interest in Learning about Science.....	13
5.1 GENERAL DISTRIBUTION OF THE RESPONSES.	14
5.2 RELATIVE POPULARITY OF TOPICS IN SECTIONS A, C & E A PRIMARY/SECONDARY COMPARISON.....	14
6. Impact of Social Factors - Books at Home and Free School Meal Entitlement	17
7. Review of the responses grouped by School - Primary Survey	20
8. More Detailed Review of ACE Section Responses	22
8.1 GENDER DIFFERENCES	22
8.2 EFFECT OF NUMBER OF BOOKS IN THE HOME	23
8.3 RELATIVE POPULARITY OF TOPICS IN DIFFERENT SUBJECT DOMAINS.....	27
8.4 INFLUENCE OF BOOK SCORE ON INTEREST IN DIFFERENT SUBJECT DOMAINS	29
8.5 TRENDS ON PROGRESSION THROUGH PRIMARY SCHOOL	30
9. Review of Sections B - H	32
9.1 COMPARISON OF OVERALL RESPONSES BETWEEN S3 PUPILS AND PRIMARY PUPILS...32	
9.2 GENDER DIFFERENCES IN SECTIONS B - H.....	34
9.3 NUMBER OF BOOKS IN THE HOME AND SECTIONS B - H	36
9.4 GENDER DIFFERENCES WITHIN THE DIFFERENT BOOKS GROUPS	37
10. Section I: What do scientists do?.....	39

11. Pupil interests versus their liking for school science and their out-of-school activities - Primary survey	41
12. Further results from the 2005/06 survey of S3 pupils: Perceptions of ACE	43
12.1 ACE SUBDIVISIONS IN S3 ROSE SURVEY	43
12.2 HOW INTEREST IN ACE TOPICS MAY BE INFLUENCED BY OTHER FACTORS.....	44
12.3 INTEREST IN ACE TOPICS DEPENDING ON THE NUMBER OF VISITS TO A SCIENCE CENTRE	53
12.4 INTEREST IN SCIENCE WITH SCHOOL QUALIFICATIONS	57
13. Sections B, D, F and G: Do perceptions change with visits to science centres?	59
13.1 SECTION B	59
13.2 SECTION D: 'ME AND THE ENVIRONMENTAL CHALLENGES'	61
13.3 SECTION F- MY SCIENCE CLASSES	63
13.4 SECTION G: OPINIONS ABOUT SCIENCE AND TECHNOLOGY	64
APPENDIX 1: THE PRIMARY SCHOOL ROSE QUESTIONNAIRE	67
APPENDIX 2: TABLE OF ACE RESULTS FOR INDIVIDUAL SCHOOLS	73
APPENDIX 3: LIKERT SCORES FOR A,C, E TOPICS LISTED BY DOMAIN	75
APPENDIX 4: THE ROSE QUESTIONNAIRE	76

Brief Overview

The Survey

As a follow up to our ROSE (Relevance of Science Education) survey of S3 pupils in Scotland completed in August 2006, we were funded by ETLLD to use the questionnaire to help with the work of the science centres. We agreed to run a modified and simplified questionnaire in primary schools at the beginning of 2007. The sample size for this survey was kept small and our targeted schools had all visited one of the four science centres

With the help of teachers and science centre staff we have:

- surveyed 17 class groups of primary 5, 6 and 7 pupils
- obtained 430 valid returns
- obtained a sample which is socially diverse and with a good mix of town and rural schools, although the sample is obviously centred mainly within a 30 mile radius of the four science centres.

This Report

In this report we outline the results obtained for primary pupils and compare these with the results of our S3 survey. We believe that a further more in depth survey on primary pupils would help throw light on questions posed as a result of the current research and we also suggest that there is scope for further more detailed analysis of the original extensive S3 data.

Main Conclusions

1. Detailed information for curriculum and event planners

Taken together, the full ROSE survey of S3 pupils and the smaller primary survey provide a wealth of detailed information of considerable potential value for informing strategies to enhance the school curriculum and the impact of science centres. The discussion presented in our two Reports can be amplified by further study of the tables and by accessing the full spreadsheets of the responses.

2. Interest higher among primary pupils

Many commentators have stated that interest in science peaks at primary age before declining as pupils progress further. Our surveys support this view, though the overall difference is not large. Mean Likert scores registering interest are typically 0.10 higher for our primary sample than for the same questions at S3 level. This corresponds to roughly a 5% "swing" in the relative proportions of positive and negative responses between the ages of 10 and 14.

3. Green light to introduce science issues

In terms of "opinions about science and technology," however, the difference between primary and secondary survey responses is somewhat greater, suggesting that a (carefully designed) "science for citizenship" educational strand could usefully begin at the upper primary stage.

4. Emergence of the influence of books

From our S3 study we identified a quite dramatic correlation between positive interest and attitudes and a pupil's estimate of the number of books in their home. Such a correlation is still present but is very much weaker for primary pupils.

5. **Considerable class cohort effects**

There is clear evidence that class cohort effects can be very significant. Analysing the mean results from each different class group, the variations found were very much larger than could have arisen by chance. Whether this is due to internal peer group influences, or to a particular teacher or school ethos, we cannot tell. We recommend further research on this issue.

6. **School's social catchment not a barrier**

In particular, the catchment area of a school, as indicated by its Free School Meals Entitlement, has no significant bearing on a class's overall interest in science.

7. **Addressing gender imbalances - start early**

At S3 level there are very large gender imbalances in interest in technology and physical science areas, which are viewed very negatively by the majority of girls. These gender differences are almost absent in the primary survey, though there remain differences between boys and girls as to which specific topics are relatively more favoured.

8. **Relative unpopularity of school science**

In both the primary and the S3 surveys, the statement "*I like school science better than most other subjects*" is disagreed with by the great majority of pupils. There is a clear correlation between individual responses to this statement and overall interest expressed in science topics, though these differences group-by-group are not as extreme as might have been anticipated.

9. **Environmental issues**

Although pupils express concern about the environment and generally think that they can make a contribution to solving issues they show a general lack of interest in learning about causes of environmental damage such as the greenhouse effect and the ozone layer. Pupils who visit science centres show more interest in learning about causes of damage than others.

10. **Science Centres associated with reinforcement of interest**

In Chapters 12 & 13 we report a range of more detailed correlations from the larger S3 survey. To pick just one more new theme that emerges, more frequent visits to science centres is associated with greater interest in science, no matter how positively or negatively pupils rate their liking for school science (see Table 12.2.4 and Fig 12.3.2). Engagement with science centres is also significantly correlated with positive attitudes to science & technology, with the largest relative impact for those taking only Standard Grade Science (see Fig 13.4.1). The interest of SG Science girls in Technology is also higher than girls in other groups.

11. **Broad similarities in reactions to topics . . .**

In broad terms, within each survey, topics that are seen as relatively interesting by one sub-group of pupils tend to be ranked reasonably highly also by other sub-groups. The same is also broadly true of topics ranked negatively.

12. **. . . but distinctive differences in top likes and dislikes**

Notwithstanding the above broad pattern, there are some clear differences in the particular topics that are most highly favoured (or most disfavoured) by different groups of pupils – as a function of age, gender, the number of books at home, and the relative liking

expressed for school science. These differences can be examined in more detail in the body of this Report, but include:

- primary pupils are more strongly interested than secondary in animals (especially), in violent events, and in scientific mysteries and blunders; they are relatively less interested in health and direct human interest topics than secondary pupils
- primary girls are more enthusiastic about animals and health topics than boys, with the boys relatively keener on space and earth science topics
- primary girls are more interested in technology than S3 girls but even secondary girls show some potential interest in the human and medical aspects of technology, expressing receptiveness to learning about the use of X-rays and ultrasound in medicine and about how mobile phones work
- primary pupils reporting the fewest levels of books at home show relatively more interest in topics related to personal health and to technology
- pupils who least like school science are relatively more interested in dramatic and personally useful topics whilst those who most like the school subject are relatively more interested in pursuing a deeper understanding of science challenges and progress
- S3 pupils who are keen on science and visit science centres often are more interested in the more theoretical aspects of science and also in nuclear energy and different forms of renewable energy. The girls also show more interest in medical matters such as gene therapy and the control of epidemics.
- S3 pupils who profess little interest in science and who never visit science centres are keener on human aspect topics, particularly those concerning fitness and sexual matters. Boys in this category also show interest, definitely not shown by the girls, in technology topics, such as, *How petrol and diesel engines work*.
- pupils in S3 taking biology at school generally prefer topics with a human focus whereas those taking physics prefer space topics.
- Pupils who visit science centres often are more inclined to accept personal responsibility for the environment, think that school science helps them in everyday life, feel encouraged to become scientists and are far keener to come up with new ideas.

13. What do scientists do and what do I want to be when I grow up?

Primary pupils were asked to name three jobs in which they thought the person doing the job needed to know lots of science.

- Many of the expected responses were obtained such as doctors, scientists, teachers, vets, astronauts, chemists, engineers etc.
- There appears to be some confusion about what scientists actually do as several pupils who said that they had no desire to be a scientist wanted to become marine biologists when they were grown up. We perhaps have more budding scientists than we think!

When asked what pupils wanted to be when they grew up:

- a large number of boys want to become sportsmen, particularly footballers.
- the most popular career choices for girls were vet, actress and hairdresser.
- more pupils wanted to be vets than doctors in this primary school survey

1. Introduction

1.1 Context

In August 2006 we produced our initial report *The ROSE Survey In Scotland*¹ which surveyed the interest in and attitudes to science of S3 pupils in Scottish secondary schools. After this survey was completed we were again funded by ETLCD to use the ROSE Questionnaire to help with the work of the science centres. After meeting with representatives of the science centres it was agreed that what they would find most useful would be:

- To devise, distribute and analyse the results from a modified ROSE Questionnaire for primary school pupils.
- To carry out a further analysis of our secondary school survey to highlight further areas of pupil interest.

1.2 The ROSE Questionnaire

The focus of the ROSE (The Relevance of Science Education) project² is on pupils' attitudes, interests and out-of-school experiences that seem relevant to the study in school of science and technology. ROSE is an international comparative research project based at the University of Oslo under the direction of Professor Svein Sjøberg.

Over 40 countries have implemented the ROSE questionnaire, including England and Northern Ireland, but Scotland did not originally participate. When the "A Curriculum for Excellence" was published in November 2004, with a radical thrust very much consistent with the specific strategy for STEM subjects that had emerged from earlier work of STEM ED Scotland³, it was thought that the time was right to ask pupils what they thought about their science lessons in school and what their attitudes were to science issues outside school.

Our first report identifies what pupil interests in science were and what could motivate them to become more involved in science topics. In common with most developed countries, in Scotland pupils are turning away from wishing to study core STEM subjects at university, or to pursue technical career paths through industry.

1.3 Modified version of the ROSE Questionnaire

The international questionnaire contains nine sections. Almost all questions in the survey ask pupils to react to particular statements or topics by responding on a four-point 'Likert' scale, signalling their level of agreement/disagreement or interest/disinterest.

The original questionnaire contained over 250 questions and it was thought that this was too lengthy a questionnaire for primary pupils and in addition it was thought that 10-11 year olds would not understand some of the questions. It was decided to shorten the survey and to simplify the language of some of the questions. All nine sections were retained in reduced form and a small section was added at the end to ask pupils what they wanted to do when they were grown up. The new survey is reproduced in Appendix 1, though the section and item numbering

¹ The ROSE Survey in Scotland, August, 2006, S Farmer, M Finlayson, B Kibble and A Roach

² Project Report and details are available at <http://www.ils.uio.no/forskning/rose/>

³ Science Education for the Future – Liberate Teachers, Engage Pupils, available at <http://www.gla.ac.uk/stem>

has been modified to match that in the full source survey (a copy of which appears in Appendix 4). This should facilitate cross comparisons with the earlier results for S3 pupils,

In the original survey form **Sections A, C and E** consisted of a total of 108 items, on 'What I want to learn about'. We classified the items in our original study as shown in the table below to seek insights into relative pupil interests in different subject areas. In our modified questionnaire for primary schools only 41 questions were asked but they represented all the 7 identified domains and were chosen to allow comparison between primary and S3 pupils. Science Centre colleagues were also consulted on which questions they thought were most relevant to their work. The number of items in each domain is shown.

Content domain	Number of questions in original S3 questionnaire	Number of questions in Primary School questionnaire
E: Earth science	11	4
P: Physical science	11	4
B: Biological science	23	7
S: Space	9	7
T: Technology	16	7
H: Human focus	30	10
N: The nature of science	8	2

These questions are listed together in Sections A, C and E in Appendix 1. We compute the 'Mean ACE score' for each pupil from their responses to all of the questions and we use this as an overall measure of their interest in learning about science.

Section B: pupils are asked to indicate the importance they attach to a number of issues for their potential future occupation or job. The scale ranges from 'Not important' to 'Very important'. Here the 26 items in the original have been reduced to 9.

Section D: invites respondents to indicate the extent to which they agree or disagree with a series of statements about the environment. Here the original 18 items have been reduced to only 4.

Sections F consists of 5 items (from an original 16) concerning pupils' views about their school science education.

Section G contains 8 questions (from an original 16) which invite pupils to indicate their degree of agreement with a series of statements about science and technology. The intention is to probe how pupils perceive the role and significance of science and technology in society.

Section H explores pupils' out-of-school experiences/activities with the 61 original items cut down to 12.

Section I This is the only part of the survey, which requires the pupil to write a response and two questions were asked. Pupils were first asked to write down three jobs in which the person doing the job would need to know lots of science and then to name 'what they wanted to be' when they grow up. The first question was asked to find out what pupils actually thought that scientists did and the second to survey their current career ambition. These replace the question in the S3 survey which asked pupils to imagine themselves as scientists and describe

the area of research they would be most interested in undertaking. We did not feel that that question was appropriate for primary pupils.

The socio-economic background of the pupils was investigated by a single question, placed as **Section J**, to estimate the number of books in their homes. This question was retained in the primary school version, as it had proved very significant in our first survey. It was also used in the PISA 2000 study and is regarded internationally as a reasonably reliable proxy indicator of socioeconomic status.

1.4 Piloting the modified survey

The above survey was arrived at following a small pilot test run with a slightly shorter version. This was run for us by Susan Hogg of Satrosphere, and involved 9 pupils from four primary schools and aged from 9-11 (P5 - P7). The time taken for the questionnaire was between 10 and 18 minutes.

The original Section I question on 'Myself as a Scientist' was retained in the pilot version, and answers were good and well thought out. However, whilst it was reported that this group had no real problems with the survey as a whole, they did require a little help with this question. Hence Section I was changed as reported above. Elsewhere only very minor changes were made as a result of the pilot exercise.

The pilot exercise satisfied us that the questionnaires could be used with pupils in the P5-P7 year groups.

2. Nature and Distribution of the survey sample

2.1 The target pupil population

It had been agreed to limit the sample size in this exercise to about 400 pupils, a much smaller scale exercise than the larger S3 survey where over 2700 responses were obtained. The primary object was to obtain an overall picture, rather than to study differentiation amongst pupils following different school courses. Primary school pupils who were due to visit the four science centres, Dynamic Earth, Sensation, Satrosphere and the Glasgow Science Centre, in January and February 2007 were the target audience.

Questionnaires were issued to class teachers who took the survey forms back to school for pupils to complete in class time. The completed forms were then returned either to the science centre or directly to the researcher.

No script had to be rejected: all appeared to have been earnestly approached and most had been fully completed. Two of the teachers commented that their class had enjoyed participating in the survey.

In our original survey when a much larger sample was obtained we were able to get a good geographic spread of schools from across Scotland. Perhaps surprisingly that while we noticed a great variety in individual responses to questions we did not find that there were any differences in responses due to locality. There were not differences of responses in rural

compared to city areas and so on. In this survey our schools were chosen by the science centre and so the schools involved tend to be in areas relatively close to the four cities where the science centres are located.

In all responses were obtained from 17 schools, 16 of which were Local Authority and one which was in the Independent sector. There were 430 responses, all judged valid.

In primary schools pupils all study the same science curriculum so there is no differentiation possible between pupils as there was when we surveyed secondary pupils. However we have pupils in three classes P5, P6 and P7 and it may be possible to detect differences in interests between the different ages although we have comparatively few Primary 5 classes participating. We also have data on the free school meals entitlement for the schools involved which we can use along with the question on the number of books in the home. This information may also show up differences in interests.

2.2 Sample characteristics

The characteristics of our sample were as follows:

Gender balance: 50.5% of pupils taking part in the survey were girls and 49.5% were boys.

Age of participants: The Table 2.2.1 below gives the spread of pupil age

Age in years	Frequency	Percent
8	1	0.2
9	45	10.5
10	141	32.8
11	229	53.2
12	14	3.2
Total	430	100.0

Table 2.2.1: Age distribution of sample

Primary classes represented: Table 2.2.2 below shows that while pupils from Primaries 5-7 participated the majority of pupils were in P7.

		Number of pupils	Percent	Cumulative Percent
Valid	Primary 5	60	14.0	14.0
	Primary 6	122	28.4	42.3
	Primary 7	248	57.7	100.0
	Total	430	100.0	

Table 2.2.2: Primary school classes involved in survey

Social mix: The ROSE Survey for S3 pupils asks one question which gives a measure of social significance, namely the pupil's estimate of the number of books in the home. We have, in Scotland, the measure which is used to estimate the relative social prosperity of a school's pupils. This is the proportion of pupils eligible to receive free school meals. We have made no attempt to get a cross section in our survey, as we did not select the schools taking part. Table 2.2.3 shows the percentage of pupils in the different bands of eligibility to apply for free school meals. Whilst our sample may not closely reflect the detailed distribution in Scotland, we have substantial representation of both low entitlement and high entitlement schools.

Percent entitlement to free meals at school	No of pupils surveyed	Valid Percent	Cumulative Percent
0%	35	8.1	8.1
Less than 10%	118	27.4	35.6
10-20%	28	6.5	42.1
20-30%	174	40.5	82.6
40-60%	16	3.7	86.3
>60%	59	13.7	100.0

Table 2.2.3 the proportion of pupils in a school able to apply for free school meals
(The banding chosen here for Primary pupils is different than that used for our S3 study)

3. Validation and Processing of Returns

Due to the smaller sample size this time the results were input manually into a SPSS spreadsheet. All of the 430 completed questionnaires were valid and none had to be discarded as no signs of frivolous replies or almost blank surveys were found.

The coding of the responses to the questionnaire was designed to be as straightforward as possible. As a general rule, the actual position of a pupil's response to an item in the questionnaire was the value to be entered. Thus, a tick in the first box opposite each item was entered as '1', in the second box as '2' and so on. The following examples illustrate what this meant in practice.

Questions A01 to A41: stem question: 'What I want to learn about'

Measurement variable: ordinal

Value labels: 1 not interested, 2 low not interested, 3 low very interested, 4 very interested

Missing value: 9

Questions C01 to C04: heading: 'Me and environmental challenges'

Measurement variable: ordinal

Value labels: 1 disagree strongly, 2 disagree, 3 agree, 4 agree strongly

Missing value: 9

Files prepared to accept data in the appropriate form, in SPSS and Excel formats, were provided by the project organisers in Oslo for the S3 pupil survey and these were modified to fit the reduced nature of the questions set in the primary school survey.

4. Interpreting the Likert Scoring System

In a preliminary study it is convenient mostly to review the 'mean Likert score' for an item or a group as a single measure of responses. The four-point scale gives information on both the direction and the intensity of each pupil's view. If one is looking for policy responses that might better engage pupils' interest, or seek to challenge their opinions, it is helpful to know not only the 'average response', but also how strongly views are held, and whether opinion is polarised. The volume of information at our disposal makes it impossible at this stage in general to explore the information in such detail.

Hence the 'mean Likert score' is the evidence most heavily referred to below. Preliminary analyses published internationally also refer mainly to these values. It is therefore important

for the reader to appreciate the significance of the range of values that this quantity might take.

On the 4-point scale the lowest two values (1.0 and 2.0) represent negative responses, whilst the highest two values (3.0 and 4.0) are weak and strong positive responses. If opinion on an item is evenly divided, and if negative views are held as strongly or weakly as are positive views, then the mean Likert score will be 2.50. So values above 2.50 can be interpreted as 'net positive' and values below 2.50 as 'net negative.'

In a survey such as this it is common for most mean Likert scores to lie quite close to the central value of 2.5, and values above 3.0 or below 2.0 tend to occur relatively rarely. In most other surveys familiar to non specialists, questions of opinion tend to be asked on a 2-point scale: the respondent is asked whether they agree or disagree with a given view, or whether they support or oppose a particular policy direction. In these 'opinion poll' terms, the balance of opinion is judged on the relative scale of the majority attributed to the prevailing view.

We chose to analyse Sec G in this manner, for our S3 survey.

Individual Likert scores of 3 or 4 were counted as representing 'agreement', and scores of 1 and 2 as 'disagreement.' Figure 4.1 compares the 'percent agreeing' and the 'mean Likert score' for each of the Sec G items.

A difference of 0.10 in the mean Likert score for an item corresponds approximately to a 10% change in the margin of the 'majority vote', for or against the proposition concerned. We think this plot is representative of the survey as a whole.

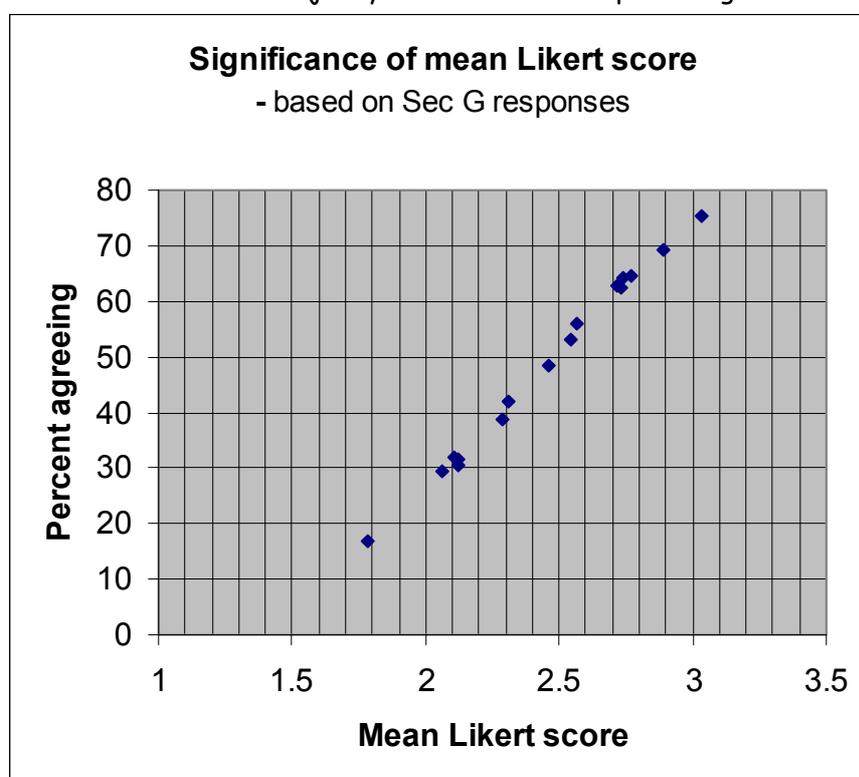


Figure 4.1 mean Likert score versus percent agreeing (from Sec G)

5. Global responses on Interest in Learning about Science

In the original questionnaire Sections A, C and E were devoted to a pupil's views of "What I want to learn about," through asking for a response on the four point scale from 'not interested' to 'very interested' for each of 108 topics. This was compressed to 41 items in the Primary survey, brought together in a single section. We had judged that Primary pupils (and their supervising teachers) would have found the full questionnaire too onerous, and in addition it was thought that some of the questions designed for an older age group might be poorly understood at this earlier age.

5.1 General distribution of the responses.

The mean Likert score across all 108 questions in Sections A, C and E has been the most prominent statistic used to compare pupil interest in science internationally. For the S3 survey in Scotland this score came in at 2.40, a net negative level quite typical of the more economically advanced societies. In the current work just 41 of these questions were included, and across these the S3 survey responses give a mean score of 2.45, still net negative, but somewhat less so. For our Primary pupils the mean score was found to be the somewhat more positive figure of 2.56. We could liken this difference as roughly akin to an opinion poll shift reversing a 53% to 47% majority view for a negative view to the same margin in favour of the positive proposition. This shift is significant though far from seismic.

Pupil responses varied widely as is shown in Fig 5.1, which shows the distribution of the mean scores for each pupil against the standard deviation of each pupil's scores for all the questions. One pupil scored 3.98 showing that almost all responses were a 4, while at the other end 1.22 was the lowest score, showing very little interest in any topic. There is obviously a wide range in net interest levels of different pupils.

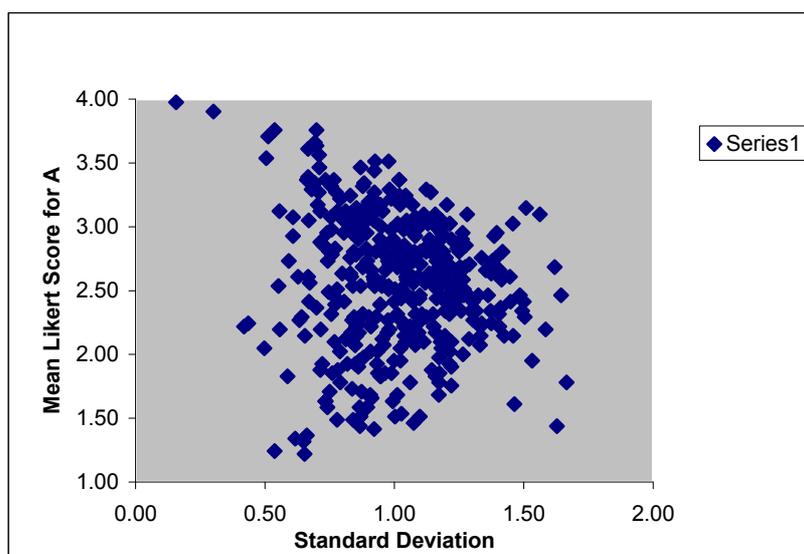


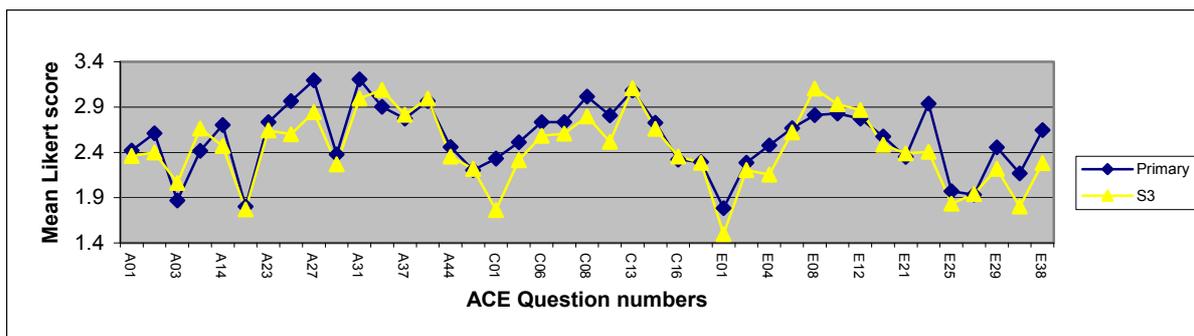
Figure 5.1: Scatter plot of Mean and SD scores for Section ACE for each pupil

Equally, however, the standard deviation data shows that most pupils expressed clear positive and negative preferences for different specific topics.

5.2 Relative popularity of topics in Sections A, C & E a Primary/Secondary comparison

We have seen that, overall, primary pupils are somewhat more interested in learning about science than S3 pupils. We now review how much interest in different specific or types of topics alters with age.

Were the interests of the two pupil groups the same or were there significant differences? Fig 5.2.1 shows the mean Likert score for each question from the two surveys. The Figure demonstrates a fairly consistent pattern with the primary pupils nearly always showing a more positive response, which in a few cases involves an increase of over 0.5 in the Likert score. There is only one question where the secondary pupils score significantly higher and this is *E08. Cancer, what we know and how we can treat it.*



A01. Stars, planets and the universe	C08. The possibility of life outside earth
A02. Chemicals, their properties and how they react	C10. Unsolved mysteries in outer space
A03. The inside of the earth	C13. Why we dream and what dreams may mean
A07. How the human body is built and functions	C14. Ghosts and witches, and whether they may exist
A14. Dinosaurs, how they lived and why they died out	C16. Why the stars twinkle and the sky is blue
A15. How plants grow and reproduce	C17. Why we can see the rainbow
A23. How meteors and comets may cause disasters	E01. Symmetries and patterns in leaves and flowers
A24. Earthquakes and volcanoes	E03. The ozone layer and how it may be affected by humans
A27. Brutal, dangerous and threatening animals	E04. The greenhouse effect & how it may be changed by us
A28. Poisonous plants in my area	E07. How to control epidemics and diseases
A31. Explosive chemicals	E08. Cancer, what we know and how we can treat it
A34. How it feels to be weightless in space	E10. How to perform first-aid and use basic medical equipment
A37. What to eat to keep healthy and fit	E12. How alcohol and tobacco might affect the body
A40. How to exercise to keep the body fit and strong	E14. Possible radiation dangers of mobile phones and computers
A44. Rockets, satellites and space travel	E21. New sources of energy from the sun, wind, tides
A47. How petrol and diesel engines work	E24. Animals in my area
C01. How crude oil is converted to other materials	E25. Plants in my area
C05. How things like radios and televisions work	E26. Detergents, soaps and how they work
C06. How mobile phones can send and receive messages	E29. The first moon landing & history of space exploration
C07. How computers work	E37. Famous scientists and their lives
	E38. Big blunders and mistakes in research and inventions

Figure 5.2.1: Mean Likert scores for Sections A, C and E for primary and S3 pupils.

The same information is given numerically in Fig 5.2.2, with the topics listed in order of popularity for the primary pupils. In the leftmost column we identify the subject domain in which we classified the topic (see §1.3 above). The 'top and bottom ten' topics are highlighted for both groups, and also those cases where the score is over 0.25 higher at primary level, and the few cases where the secondary score is at least 0.10 higher.

- There are eight common topics for both groups, in both their 'top ten' and 'bottom ten' topics, although the order within these topics is significantly different.
- Primary pupils seem more interested in violent events and animals, and relatively less interested in topics of human interest.
- Cancer is tenth on the primary list whereas it is second top for S3 pupils. All three Human Interest 'health' topics are in fact still relatively popular with primaries, being ranked 10, 12 and 13, though all are counter-trend topics that seem to gain in popularity on progression to secondary.
- *Earthquakes and volcanoes* provoke much more interest among primary pupils. We wondered if this interest might have been aroused particularly among Edinburgh pupils who had visited Our Dynamic Earth. The two Edinburgh schools in our survey scored this item higher than average for all schools, but there were higher scores from some schools in other regions.
- A greater general level of curiosity at the primary level might be suggested by the greater scores accorded to topics on 'unsolved mysteries', 'why dinosaurs died out', and 'big blunders in research and inventions'.
- Among topics that are still unpopular, but much less so for primary pupils, are the greenhouse effect and how crude oil is converted.

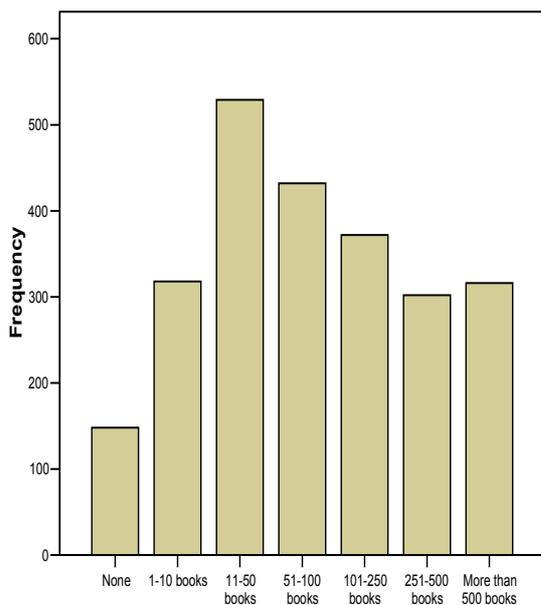
Domain	Topic	Primary pupils	Rank	S3 Pupils	Rank	Difference in MLS
P	A31. Explosive chemicals	3.20	1	2.99	5	0.21
B	A27. Brutal, dangerous and threatening animals	3.20	2	2.84	8	0.35
H	C13. Why we dream and what dreams may mean	3.08	3	3.11	1	-0.03
S	C08. The possibility of life outside earth	3.02	4	2.80	10	0.22
H	A40. How to exercise to keep the body fit and strong	2.97	5	2.99	4	-0.03
E	A24. Earthquakes and volcanoes	2.96	6	2.60	16	0.36
B	E24. Animals in my area	2.94	7	2.41	21	0.53
S	A34. How it feels to be weightless in space	2.90	8	3.09	3	-0.19
H	E10. How to perform first-aid and use basic medical equipment	2.83	9	2.93	6	-0.10
H	E08. Cancer, what we know and how we can treat it	2.81	10	3.10	2	-0.29
S	C10. Unsolved mysteries in outer space	2.81	11	2.52	18	0.29
H	E12. How alcohol and tobacco might affect the body	2.77	12	2.87	7	-0.09
H	A37. What to eat to keep healthy and fit	2.77	13	2.82	9	-0.04
E	A23. How meteors and comets may cause disasters	2.73	14	2.64	13	0.09
T	C06. How mobile phones can send and receive messages	2.73	15	2.58	17	0.15
T	C07. How computers work	2.73	16	2.61	15	0.12
H	C14. Ghosts and witches, and whether they may exist	2.72	17	2.66	12	0.07
E	A14. Dinosaurs, how they lived and why they died out	2.70	18	2.47	20	0.24
H	E07. How to control epidemics and diseases	2.67	19	2.62	14	0.05
N	E38. Big blunders and mistakes in research and inventions	2.65	20	2.28	29	0.36
P	A02. Chemicals, their properties and how they react	2.61	21	2.40	22	0.21
T	E14 Possible radiation dangers of mobile phones and computers	2.58	22	2.48	19	0.09
T	C05. How things like radios and televisions work	2.51	23	2.31	27	0.20
H	E04. The greenhouse effect & how it may be changed by us	2.48	24	2.16	34	0.32
S	A44. Rockets, satellites and space travel	2.46	25	2.35	26	0.11
S	E29. The first moon landing & history of space exploration	2.45	26	2.22	31	0.23
S	A01. Stars, planets and the universe	2.42	27	2.36	24	0.06
B	A07. How the human body is built and functions	2.42	28	2.66	11	-0.25
B	A28. Poisonous plants in my area	2.38	29	2.27	30	0.11
T	E21. New sources of energy from the sun, wind, tides	2.35	30	2.39	23	-0.04
P	C01. How crude oil is converted to other materials	2.33	31	1.76	40	0.57
S	C16. Why the stars twinkle and the sky is blue	2.32	32	2.35	25	-0.03
P	C17. Why we can see the rainbow	2.29	33	2.28	28	0.01
H	E03. The ozone layer and how it may be affected by humans	2.29	34	2.21	33	0.08
T	A47. How petrol and diesel engines work	2.21	35	2.22	32	-0.01
N	E37. Famous scientists and their lives	2.17	36	1.80	38	0.37
B	E25. Plants in my area	1.97	37	1.83	37	0.14
P	E26. Detergents, soaps and how they work	1.93	38	1.94	36	-0.01
E	A03. The inside of the earth	1.87	39	2.06	35	-0.20
B	A15. How plants grow and reproduce	1.80	40	1.77	39	0.03
B	E01. Symmetries and patterns in leaves and flowers	1.79	41	1.50	41	0.29
Mean ACE score		2.56		2.45		

Figure 5.2.2: Differences in interests between primary and secondary S3 pupils for Sections ACE

6. Impact of Social Factors - Books at Home and Free School Meal Entitlement

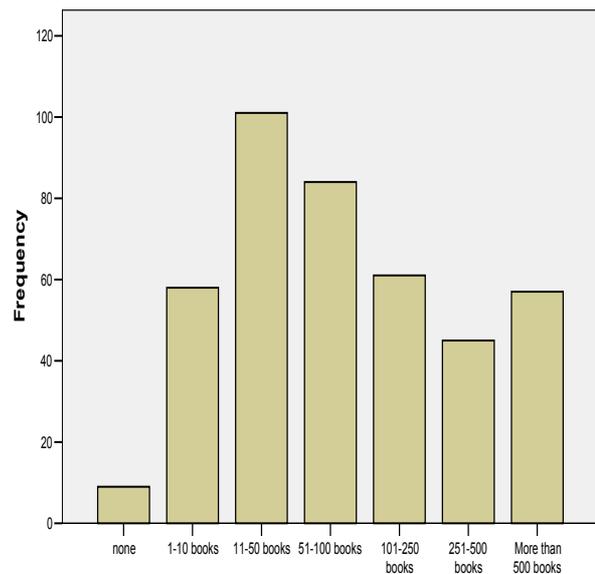
In our Secondary (S3) survey the responses to the single question in Section H, about the number of books in the pupil's home, correlated more strongly with differences in views and attitudes among pupils than any other single factor considered. Its significance came to our attention repeatedly as we reviewed the S3 survey responses.

There is strong research evidence of a relationship between educational achievement and the economic, social and cultural capital of a pupils' parents^{4,5}. This has been explained on the basis that the parents of higher socio-economic status (SES) are more involved in the education of their children than parents with lower SES, and that they stimulate more positive attitudes and greater motivation to learn. Given that quite diverse countries are participants in the ROSE survey it was not easy to identify questions, which were similarly applicable worldwide. It was decided to include just one question relating to this factor. The selected question: "How many books are in your home?" had also been used, along with other socio-economic questions, in the PISA 2000 survey. The number of books in a household is regarded as an indicator of a household's SES and a correlation between number of books in the home and reading literacy in the G8 countries has been found⁶.



Secondary School Survey

Fig. 6.1: How many books are in your home?



Primary School Survey

Fig. 6.2: How many books are in your home?

Figs 6.1 and 6.2 above show the responses in both surveys to the 'books' question. In our S3 survey a little over 6% of pupils reported that there were no books at all in their homes, whilst

⁴ Ho Sui-Chu and Williams, Effects of Parental Involvement on 8th Grade Achievement: *Sociology of Education*, 69, pp106-141

⁵ Socio-economic status relates to "an individual's or group's position within a hierarchical social structure." It "depends on a combination of variables, including occupation, education, income, wealth, and place of residence. Sociologists often use socio-economic status as a means of predicting behaviour." *New Dictionary of Cultural Literacy*, 3rd Edition. 2002.

⁶ Comparative Indicators of Education in the United States and Other G8 Countries:2004. Anindita Sen, Lisette A. Partelow, David C. Miller. U.S. Department of Education, Institute of Education Sciences. NCEES 2005-021.

13% estimated that there were over 500. The full distribution of responses is shown in Fig 6.1. Our sample of primary pupils was only about 15% the size of our S3 survey and perhaps was not as representative of the school population of Scotland as a whole but the graph obtained for the number of books in the home is remarkably similar although there is a smaller percentage with no books in the home at 2.2%. In both surveys over 13% of pupils estimate that there are over 500 books in their home.

In our S3 secondary survey we found that a strongly significant correlation between the 'mean book score' for a class, and their level of interest in science as measured by their mean ACE score.

Fig 6.3 shows this analysis for both the S3 and the primary surveys (with the S3 data recalculated using only the subset of questions used also for primary pupils). For S3 pupils, all but the top three groups are 'net negative' (the 'neutral' score is 2.50) and the bottom group's score of 2.15 reflects a strongly expressed lack of interest in learning about science.

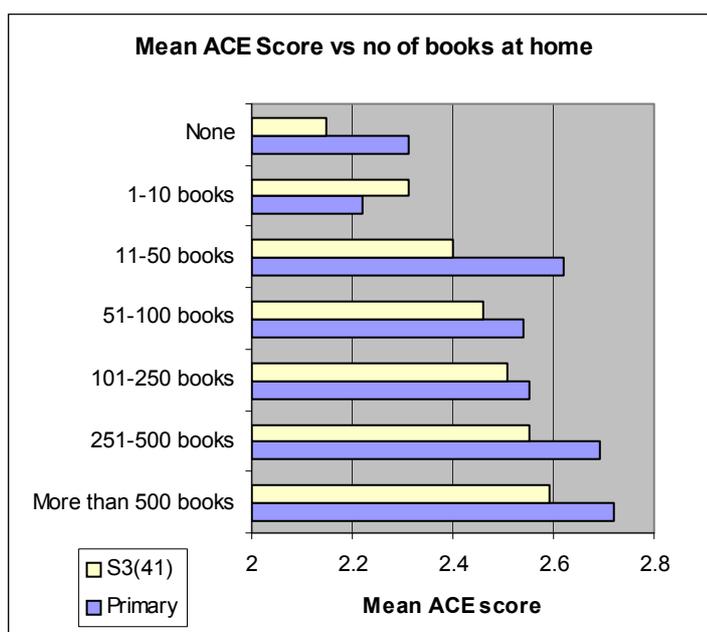


Fig 6.3 Mean ACE score vs. no of books at home

For primary pupils, the correlation between the number of books in a home and interest in science topics is very much less pronounced, particularly beyond a threshold level of 10 books. It is also evident that Mean ACE scores are significantly higher across the board for primary pupils with all but the two lowest book groups being 'net positive' (mean ACE score above 2.50).

Fig 6.4 looks separately at the different primary year groups. There appears to be an overall decline in interest from P5 to P7, but this conclusion must be treated with caution. Our P5 sample includes only 2 classes, and our analysis below presents strong evidence for significant specific class-cohort effects). The less pronounced differences across the five highest book groups seem to persist to P7 level.

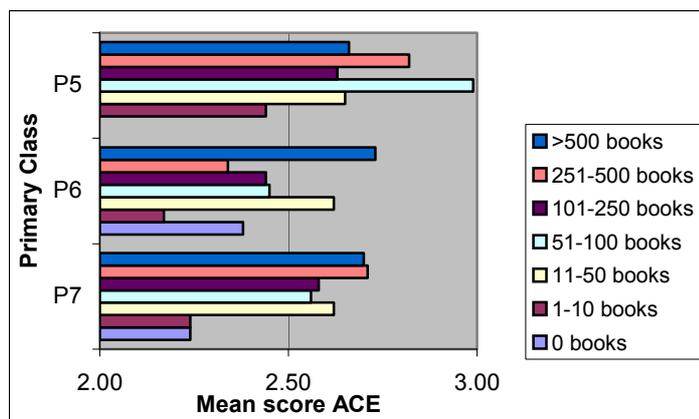


Fig 6.4: Mean ACE score versus books for P5, P6 and P7

The percentage of pupils with free school meal entitlement (FSME) is the standard indicator used in Scotland to reflect the social and economic catchment of a school. The FSME indicator

reflects the average economic background of pupils across the whole school rather than for the particular class groups responding to the survey; however class groups should on average be representative of their schools, so if a strong correlation existed between social & economic background and attitudes to science we would expect this to show through. Our S3 survey revealed no correlation between pupil interest in science and their school's FSME and this was shown graphically using a scatter plot. The corresponding scatter plot is given on the left of Fig 6.5 below.

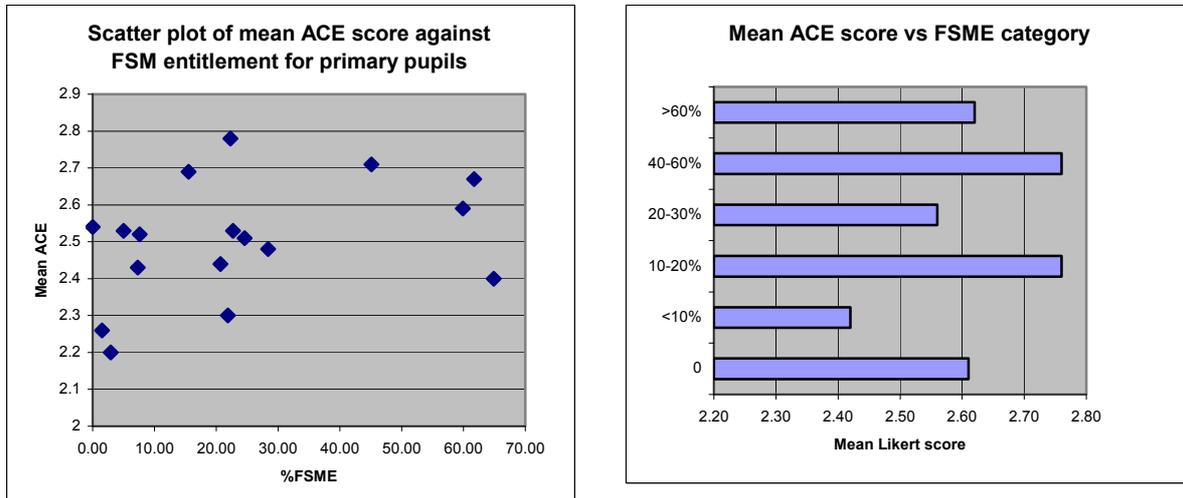


Fig 6.5: Relationship between interest in science and FSME

With only 17 schools in our present survey the scatter plot is difficult to interpret. The bar chart constructed grouping the schools into bands by FSME probably better shows that no clear trend is evident. Formally the data has a weak positive correlation, suggesting that interest in science might be stronger in schools with higher entitlement to free meals! We argue below that our data set is insufficient to justify such a conclusion. On the other hand, we can assert that any effect of the FSME status of a school on the mean ACE score is relatively small compared with the effect of other factors.

7. Review of the responses grouped by School - Primary Survey

In our earlier Report of the S3 ROSE survey we included an analysis of differences between the response patterns of different class groups. Whilst there were considerable divergences between different class groups studying the same curricula we found no systematic correlations between these and the geographic, environmental or social context of the different schools. The only significant correlation of differences found was with the mean books score for the class concerned. Here we report efforts to identify class effects in the Primary survey, as reflected in the levels of interest expressed in learning about the ACE topics.

School ID no	Science centre	Primary year	FSME band	Mean ACE score
6	2	P5	3	2.85
8	2	P7	4	2.76
11	3	P7	2	2.76
12	4	P7	5	2.73
15	4	P6	5	2.66
17	2	P5	0	2.61
9	1	P6	3	2.60
13	4	P7	1	2.58
2	1	P7	3	2.57
10	3	P6/7	1	2.57
16	4	P7	3	2.54
1	1	P7	1	2.49
14	4	P6	3	2.48
3	1	P6	5	2.44
7	2	P7	3	2.36
4	1	P6	1	2.31
5	2	P7	1	2.25

Fig 7.1: Mean ACE scores for the schools surveyed

Across the 17 schools involved there was a wide variation in the mean ACE scores, ranging from 2.85 to 2.25. Fig 7.1 lists these values, together with information on the Science Centre area in which the school was located, the primary year level surveyed and the school's Free School Meals entitlement band.

The schools are arranged in order of decreasing mean ACE score. There are no immediately evident correlations with geography, year level or FSME. This is in itself a significant conclusion: the very considerable variation between different classes appears to be dominated by group cohort effects of some sort, whether reflecting the influence of a particular teacher, an individual peer group effect, an aspect of the particular school's ethos, or whatever. The differences are far too large to be random sample variations.

More detail is available in Appendix 2 where the mean response to each ACE question is given for each school.

We can demonstrate the magnitude of class cohort effects by attempting to look for a relationship between the class average books score and the mean ACE score for the class. As anticipated the mean books score for a class is lower for classes with higher Free School Meals Entitlement levels (over the 17 schools the mean book score and the FSME band have a Pearson correlation coefficient $r = -0.67$ (significant at 99.5% level). For individual pupils there is a definite, albeit weak, correlation between book score and mean ACE score ($r = +0.203$, 99.9% significance). However, over the 17 classes, the mean book score for the pupils does not correlate with the class mean ACE score ($r = -0.066$, 'significance level' <20%). The reality of the books effect on individuals demonstrated in §5 above and elsewhere, is hidden by the larger class-by-class variations.

We can further reinforce the significance of class cohort effects by considering also the relation between mean ACE scores and FSME. Over the 430 pupils there is a very weak (and positive) correlation between these variables ($r = +0.094$, 95% significant). This marginal but unexpected result shows that pupils with higher FSME are giving higher mean ACE scores than would be expected on the basis of their (on average) lower book scores. Aggregating this data into the 17 class groups actually increases the correlation coefficient (to $r = +0.326$) though it

reduces its statistical significance to just 80%. The reduced statistical significance reflects the variability of the mean scores for different classes in each FSME band, and the lack of a settled trend across bands (as demonstrated earlier in Fig 6.5). In other words it reflects strong class cohort effects.

It is unsafe to draw any too firm conclusions from this small number of classes, except that there **are** strong class cohort effects. From a science enhancement point of view this presents opportunities. At primary level economic and social background appear not to inhibit the possibility of attracting interest in science!

Fig 7.2 below lists the 'top ten' most popular ACE topics, for pupils visiting each of the four regional science centres. The variation is small with each group sharing at least eight of their top ten with the overall top ten. Particularly in the light of the above comments, nothing else stands out as worthy of comment.

Number visiting different science centres	140		129		50		110		Overall	
Science centre visited	Aberdeen	rank	Dundee	Rank	Edinburgh	Rank	Glasgow	Rank	rank	
Topic / Mean ACE score										
A31. Explosive chemicals	3.09	1	3.11	2	3.27	3	3.44	1	1	P
A27. Brutal, dangerous and threatening animals	3.01	2	3.16	1	3.48	1	3.34	2	2	B
C13. Why we dream and what dreams may mean	2.95	4	3.07	3	3.28	2	3.17	3	3	H
C08. The possibility of life outside earth	2.97	3	2.88	7	3.20	4	3.15	4	4	S
A40. How to exercise to keep the body fit and strong	2.95	5	2.92	5	3.16	7	2.95	7	5	H
A24. Earthquakes and volcanoes	2.91	6	2.91	6	3.18	6	3.01	6	6	E
E24. Animals in my area	2.88	8	3.00	4	3.00	14	2.91	9	7	B
A34. How it feels to be weightless in space	2.88	7	2.67	18	3.10	11	3.13	5	8	S
E10. How to perform first-aid and use medical equipment	2.75	12	2.85	8	3.12	10	2.76	14	9	H
E08. Cancer, what we know and how we can treat it	2.69	13	2.83	10	3.12	9	2.80	11	10	H
C10. Unsolved mysteries in outer space	2.81	9	2.64	20	2.92	16	2.95	8	11	S
E12. How alcohol and tobacco might affect the body	2.66	15	2.77	12	2.84	19	2.89	10	12	H
A37. What to eat to keep healthy and fit	2.81	10	2.81	11	2.82	20	2.66	18	13	H
A23. How meteors and comets may cause disasters	2.59	18	2.74	14	3.14	8	2.73	15	14	E
C07. How computers work	2.64	16	2.84	9	2.80	21	2.70	17	16	T
C14. Ghosts and witches, and whether they may exist	2.60	17	2.68	16	3.20	5	2.72	16	17	H

Fig 7.2: The most popular ACE topics for pupils in each Science Centre area

8. More Detailed Review of ACE Section Responses

8.1 Gender differences

Mean Likert scores for boys and girls in S3 and in primary school											
	Dom ain	S3 Pupils				Topic	Primary pupils				
		Girl		Boy			Girl		Boy		
		1453	Rank	1273	Rank		217	Rank	213	Rank	
C13	H	3.31	1	2.89	8	C13. Why we dream and what the dreams may mean	3.27	1	2.89	10	
E24	B	2.50	15	2.30	30	E24. Animals in my area	3.22	2	2.65	19	
A27	B	2.72	11	2.98	3	A27. Brutal, dangerous and threatening animals	3.16	3	3.24	2	
E08	H	3.27	2	2.92	5	E8. Cancer, what we know and how we can treat it	2.98	4	2.63	21	
E10	H	3.07	4	2.78	10	E10. How to perform first-aid and use basic medical equipment	2.94	5	2.71	15	
A40	H	3.07	3	2.91	7	A40. How to exercise to keep the body fit and strong	2.94	6	3.00	6	
A31	P	2.72	12	3.32	1	A31. Explosive chemicals	2.93	7	3.49	1	
C14	H	2.84	8	2.45	26	C14. Ghosts and witches, and whether they may exist	2.89	8	2.55	23	
A37	H	2.98	7	2.63	18	A37. What to eat to keep healthy and fit	2.88	9	2.66	18	
A34	S	3.01	5	3.18	2	A34. How it feels to be weightless in space	2.88	10	2.93	9	
E12	H	2.99	6	2.73	13	E12. How alcohol and tobacco might affect the body	2.81	11	2.73	14	
C08	S	2.67	13	2.95	4	C8. The possibility of life outside earth	2.81	12	3.23	3	
C06	T	2.52	14	2.65	16	C6. How mobile phones can send and receive messages	2.78	13	2.68	16	
A24	E	2.48	16	2.74	12	A24. Earthquakes and volcanoes	2.78	14	3.16	4	
E14	T	2.47	17	2.50	23	E14. The possible radiation dangers of mobile phones and computers	2.72	15	2.43	30	
E07	H	2.74	10	2.47	25	E7. How to control epidemics and diseases	2.71	16	2.62	22	
C07	T	2.35	22	2.91	6	C7. How computers work	2.68	17	2.78	12	
C10	S	2.42	20	2.64	17	C10. Unsolved mysteries in outer space	2.64	18	2.98	7	
C16	S	2.46	18	2.22	32	C16. Why the stars twinkle and the sky is blue	2.55	19	2.08	36	
A02	P	2.30	24	2.52	21	A2. Chemicals, their properties and how they react	2.53	20	2.68	17	
A23	E	2.45	19	2.87	9	A23. How meteors and comets may cause disasters	2.51	21	2.96	8	
A07	B	2.81	9	2.50	22	A7. How the human body is built and functions	2.50	22	2.33	33	
E04	H	2.14	29	2.17	33	E4. The greenhouse effect and how it may be changed by humans	2.49	23	2.46	27	
C17	P	2.39	21	2.17	34	C17. Why we can see the rainbow	2.49	24	2.09	35	
C05	T	2.12	30	2.54	19	C5. How things like radios and televisions work	2.47	25	2.55	25	
E38	N	2.10	31	2.49	24	E38. Big blunders and mistakes in research and inventions	2.44	26	2.85	11	
A14	E	2.27	26	2.69	15	A14. Dinosaurs, how they lived and why they died out	2.39	27	3.02	5	
A01	S	2.31	23	2.43	27	A1. Stars, planets and the universe	2.37	28	2.47	26	
C01	T	1.60	40	1.94	36	C1. How crude oil is converted to other materials, like plastics	2.32	29	2.34	32	
A28	B	2.18	28	2.36	29	A28. Poisonous plants in my area	2.32	30	2.44	29	
E29	S	2.07	32	2.40	28	E29. The first landing on the moon and the history of space exploration	2.27	31	2.64	20	
E21	T	2.27	25	2.52	20	E21. New sources of energy from the sun, wind, tides, waves, etc.	2.25	32	2.45	28	
A44	S	2.00	34	2.76	11	A44. Rockets, satellites and space travel	2.19	33	2.74	13	
E03	H	2.19	27	2.23	31	E3. The ozone layer and how it may be affected by humans	2.18	34	2.39	31	
E25	B	1.84	36	1.83	39	E25. Plants in my area	2.09	35	1.85	37	
E37	N	1.69	39	1.92	37	E37. Famous scientists and their lives	2.06	36	2.28	34	
E26	P	2.00	35	1.87	38	E26. Detergents, soaps and how they work	2.04	37	1.83	38	
E01	B	1.57	41	1.42	41	E1. Symmetries and patterns in leaves and flowers	1.99	38	1.58	41	
A04	E	2.02	33	2.08	35	A3. The inside of the earth	1.96	39	1.78	39	
A15	B	1.79	37	1.75	40	A15. How plants grow and reproduce	1.90	40	1.70	40	
A47	T	1.78	38	2.71	14	A47. How petrol and diesel engines work	1.87	41	2.55	24	
Mean ACE		2.40		2.50			2.54		2.57		

Figure 8.1: Difference in interests by gender

Fig 8.1 presents a comparison of responses in both surveys, by gender.

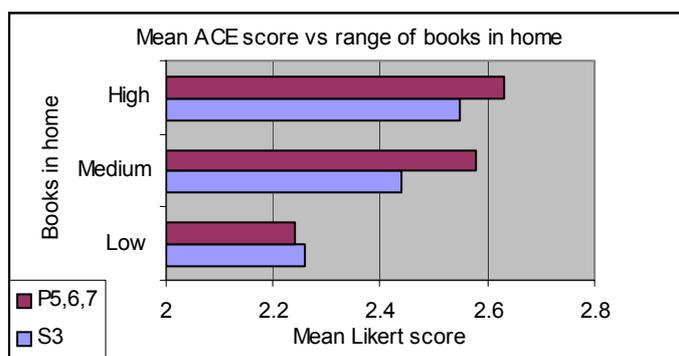
The points we would highlight from the above data are:

- Seven of the top ten topics for primary girls are shared with S3 girls. Both groups are most interested in human interest topics followed by topics in the biological domain. Older girls are more concerned about disease, how to cure it and how the human body functions whereas primary girls have a greater interest in animals.
- Primary boys and girls only share five topics in their top ten lists. Primary boys are much more interested than other groups in earth science topics with three from this domain in their top ten. Primary school boys share the interest of other boys in the exciting and dangerous. S3 boys share seven of their top ten but only three are shared with S3 girls and these are the human interest topics. Primary boys are much less interested in disease and its cures or in animals or the supernatural.
- Only three topics are common to the 'top ten' for all four lists. These are: cause and meaning of dreams, how to exercise to keep fit and healthy and how it feels to be weightless in space. Dangerous animals and explosive chemicals are near misses in this regard.
- Primary girls are the only group for whom 'animals in my area' are a strong interest whilst primary boys are the only group with top ten interests in dinosaurs, earthquakes and unsolved mysteries in outer space.

8.2 Effect of Number of books in the home

Due to the smaller scale of our Primary school survey and the small numbers involved in some of the seven book categories used initially we decided to subdivide our sample into only three groupings which we label 'Low' (for 0-10 books), 'Medium' (for 11-100 books) and 'High' (for over 100 books). For comparison purposes we subdivided our S3 sample in the same way. Fig 8.2.1 shows the mean ACE scores for the three book categories for both S3 and primary pupils over the 41 topics included in both surveys. This diagram reinforces the conclusions drawn in S5 above - for the primary age group both the Medium and High book groups (almost 85% of our primary sample) show significantly more interest than the corresponding S3 groups. The most dramatic difference is with the Medium group, who express almost as strong interest as the High books group. Upper primary would appear to be an opportune stage at which to intervene to try to consolidate the interest of the Medium group.

In contrast, the Low book group at primary level appears marginally even less interested than their secondary counterparts.



	Book group	Low 0-10	Medium 11-100	High >100
P5,6,7	Number	67	183	160
	meanACE	2.24	2.58	2.63
S3	Number	467	960	989
	meanACE	2.26	2.44	2.55

Figure 8.2.1: ACE scores vs Books in the home

For the primary pupils, in Fig 8.2.2 below, we look further at how gender interplays with the interest level of the different book groups. The overall gender effects seem substantial only for the High group; with boys registering a 0.20 higher mean Likert score.

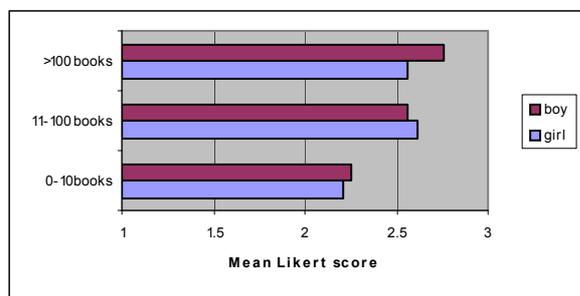


Fig 8.2.2: Interest in Primary by books & gender

Primary	Book group	Low 0-10	Medium 11-100	High >100
Girls	Number	28	95	74
	meanACE	2.21	2.61	2.56
Boys	Number	39	86	58
	meanACE	2.25	2.56	2.76

The table presented in Fig 8.2.3 lists the different interest levels recorded for each specific topic by the different book groupings for both primary and secondary pupils, with the primary data further broken down by gender in Fig 8.2.4.

- Detailed examination of these tables can reveal quite significant and sometimes subtle differences in the perceived attractiveness of specific topics for different groups
- The High and Medium books groups have very similar relative interest levels across the topics, and the quite large gender differences are quite similar for these groups. However there are much larger differences between these and the Low books group.
- Explosive chemicals, brutal and dangerous animals and how to exercise to keep fit and healthy are the only topics popular across all groups
- Boys are much more interested in some earth science topics, particularly boys from the Medium and High groups.
- Girls in the High books primary group seem strikingly interested in the paranormal.
- Primary girls are much less interested in space travel and exploration than boys in all the book categories.
- The Low books group are more distinctive, with relatively stronger interest in some personal health issues, and also in technology topics such as *how computers work*, *how petrol and diesel engines work* and even *how crude oil can be converted into other materials*. Primary girls are actually somewhat more interested than boys in crude oil conversion, but emphatically not so when it comes to engines.

Book Grouping	Low				Medium				High			
	S3		P		S3		P		S3		P	
Primary or Secondary	467		67		960		183		989		160	
No in group												
Topic	score	rank	score	rank	score	rank	score	rank	score	rank	score	rank
A27. Brutal, dangerous and threatening animals	2.52	11	2.97	2	2.86	8	3.19	2	3.02	7	3.28	1
C13. Why we dream and what the dreams may mean	2.92	2	2.67	8	3.17	1	3.15	3	3.15	3	3.19	2
E24. Animals in my area	2.23	21	2.41	15	2.39	21	2.91	8	2.53	23	3.16	3
A31. Explosive chemicals	2.93	1	3.23	1	2.95	5	3.25	1	3.11	5	3.09	4
C08. The possibility of life outside earth	2.44	14	2.64	9	2.79	10	3.09	4	3.02	6	3.08	5
A40. How to exercise to keep the body fit and strong	2.91	4	2.94	3	3.05	4	3.04	5	3.01	8	2.94	6
E10. How to perform first-aid	2.70	8	2.43	14	2.92	6	2.85	10	3.11	4	2.94	7
A34. How it feels to be weightless in space	2.83	5	2.52	10	3.09	3	3.03	6	3.26	1	2.93	8
C14. Ghosts and witches, and whether they may exist	2.57	9	2.34	20	2.68	12	2.74	17	2.69	16	2.89	9
A24. Earthquakes and volcanoes	2.31	18	2.94	4	2.59	17	3.01	7	2.74	15	2.89	10
E08. Cancer, what we know and how we can treat it	2.91	3	2.52	11	3.11	2	2.83	12	3.20	2	2.87	11
C10. Unsolved mysteries in outer space	2.17	25	2.34	19	2.46	19	2.89	9	2.75	14	2.86	12
C07. How computers work	2.46	13	2.69	7	2.65	13	2.64	19	2.67	17	2.82	13
A23. How meteors and comets may cause disasters	2.38	16	2.13	25	2.63	14	2.83	11	2.81	11	2.81	14
C06. How mobile phones can send & receive messages	2.53	10	2.49	12	2.60	16	2.74	16	2.59	20	2.79	15
E07. How to control epidemics and diseases	2.29	20	2.34	18	2.63	15	2.64	20	2.77	13	2.79	16
A37. What to eat to keep healthy and fit	2.73	7	2.71	6	2.86	7	2.80	14	2.83	10	2.78	17
E38. Big blunders and mistakes in research	1.99	31	1.95	29	2.21	30	2.69	18	2.51	25	2.77	18
A14. Dinosaurs, how they lived and why they died out	2.20	22	2.38	17	2.47	18	2.77	15	2.60	18	2.73	19
E12. How alcohol and tobacco might affect the body	2.81	6	2.73	5	2.85	9	2.81	13	2.91	9	2.72	20
E14. The possible radiation dangers of mobile phones	2.34	17	2.16	24	2.45	20	2.58	24	2.59	21	2.71	21
A01. Stars, planets and the universe	2.01	29	1.79	33	2.33	24	2.45	26	2.58	22	2.62	22
A02. Chemicals, their properties and how they react	2.39	15	2.46	13	2.36	22	2.58	22	2.47	26	2.62	23
E04. The greenhouse effect	1.81	36	2.13	26	2.10	34	2.43	27	2.35	32	2.59	24
A28. Poisonous plants in my area	1.96	32	1.91	31	2.27	28	2.37	29	2.43	28	2.57	25
A07. How the human body is built and functions	2.48	12	2.22	22	2.69	11	2.41	28	2.77	12	2.53	26
C05. How things like radios and televisions work	2.16	26	2.21	23	2.33	25	2.58	23	2.38	30	2.51	27
E21. New sources of energy from the sun, wind etc.	2.13	28	1.70	37	2.34	23	2.36	31	2.60	19	2.51	28
A44. Rockets, satellites and space travel	2.14	27	1.98	27	2.31	27	2.56	25	2.51	24	2.48	29
E29. The first moon landing & space exploration	1.99	30	1.91	30	2.15	33	2.59	21	2.40	29	2.45	30
C16. Why the stars twinkle and the sky is blue	2.19	24	1.90	32	2.33	26	2.34	34	2.43	27	2.43	31
E03. The ozone layer	1.85	35	1.75	34	2.21	31	2.34	33	2.37	31	2.38	32
C17. Why we can see the rainbow	2.29	19	1.95	28	2.23	29	2.37	30	2.31	33	2.33	33
C01. How crude oil is converted to other materials	1.64	38	2.23	21	1.77	38	2.35	32	1.82	40	2.29	34
E37. Famous scientists and their lives	1.72	37	1.72	36	1.76	40	2.16	35	1.85	38	2.26	35
A47. How petrol and diesel engines work	2.19	23	2.40	16	2.21	32	2.12	36	2.19	34	2.23	36
E25. Plants in my area	1.63	39	1.55	39	1.80	37	1.96	37	1.95	36	2.16	37
E26. Detergents, soaps and how they work	1.92	33	1.73	35	1.98	36	1.89	38	1.92	37	2.02	38
A15. How plants grow and reproduce	1.63	40	1.46	41	1.77	39	1.75	41	1.85	39	2.01	39
A03. The inside of the earth	1.88	34	1.61	38	2.04	35	1.85	39	2.17	35	1.99	40
E01. Symmetries and patterns in leaves and flowers	1.45	41	1.48	40	1.48	41	1.80	40	1.51	41	1.88	41
Mean Likert score	2.26		2.16		2.44		2.56		2.55		2.62	

Fig 8.2.3: Interest in ACE topics for different book groupings for Primary and S3 pupils

		Book grouping		Low		Medium				High					
		Number in group		28		39		95		86		74		58	
		Gender		Girls		Boys		Girls		Boys		Girls		Boys	
Dom	Topic	score	rank	score	rank	score	rank	score	rank	score	rank	score	rank	score	rank
B	E24. Animals in my area	2.89	5	2.08	27	3.14	3	2.72	15	3.34	1	2.91	15		
H	C13. Why we dream and what dreams may mean	2.96	3	2.46	15	3.35	1	2.93	11	3.26	2	3.11	9		
B	A27. Brutal, dangerous and threatening animals	2.54	10	3.28	2	3.21	2	3.17	3	3.22	3	3.24	4		
H	C14. Ghosts and witches, and whether they may exist	2.36	16	2.33	19	2.91	11	2.55	21	3.09	4	2.69	29		
H	E10. How to perform first-aid and use basic medical equipment	2.46	12	2.41	18	3.05	6	2.64	17	3.04	5	2.84	18		
P	A31. Explosive chemicals	3.00	1	3.38	1	2.95	9	3.60	1	2.91	6	3.45	1		
H	A40. How to exercise to keep the body fit and strong	2.96	2	2.92	4	3.09	5	2.94	9	2.88	7	3.07	10		
H	E08. Cancer, what we know and how we can treat it	2.61	8	2.45	16	3.12	4	2.52	24	2.86	8	2.93	14		
S	A34. How it feels to be weightless in space	2.43	14	2.59	11	3.03	7	3.09	5	2.85	9	3.05	11		
H	A37. What to eat to keep healthy and fit	2.89	4	2.59	10	3.00	8	2.55	22	2.81	10	2.71	26		
T	C06. How mobile phones can send and receive messages	2.50	11	2.49	14	2.89	14	2.56	20	2.77	11	2.90	16		
T	E14. The possible radiation dangers of mobile phones	2.29	18	2.08	28	2.78	17	2.36	30	2.77	12	2.76	22		
S	C08. The possibility of life outside earth	2.39	15	2.82	5	2.91	12	3.33	2	2.76	13	3.41	2		
T	C07. How computers work	2.54	9	2.79	7	2.67	18	2.60	18	2.74	14	3.03	12		
H	E12. How alcohol and tobacco might affect the body	2.71	7	2.74	8	2.90	13	2.72	14	2.73	15	2.62	31		
H	E07. How to control epidemics and diseases	2.25	20	2.41	17	2.79	16	2.49	25	2.73	16	2.86	17		
E	A24. Earthquakes and volcanoes	2.71	6	3.10	3	2.92	10	3.12	4	2.68	17	3.21	6		
S	C10. Unsolved mysteries in outer space	2.14	25	2.49	13	2.81	15	2.98	8	2.58	18	3.29	3		
S	C16. Why the stars twinkle and the sky is blue	2.25	19	1.64	37	2.64	19	2.05	36	2.58	20	2.41	34		
N	E38. Big blunders and mistakes in research and inventions	1.63	39	2.18	24	2.48	26	2.93	10	2.58	19	3.12	8		
B	A07. How the human body is built and functions	2.19	23	2.23	22	2.53	24	2.27	34	2.54	21	2.40	35		
P	A02. Chemicals, their properties and how they react	2.43	13	2.49	12	2.48	27	2.69	16	2.53	23	2.74	23		
E	A23. How meteors and comets may cause disasters	1.96	26	2.26	20	2.61	21	3.05	6	2.53	22	3.16	7		
S	A01. Stars, planets and the universe	1.75	34	1.82	31	2.37	30	2.53	23	2.50	24	2.72	25		
H	E04. The greenhouse effect and how it may be changed	2.18	24	2.10	26	2.56	23	2.31	31	2.47	25	2.69	30		
B	A28. Poisonous plants in my area	1.89	28	1.92	30	2.30	33	2.48	26	2.46	27	2.71	28		
T	C05. How things like radios and televisions work	2.21	22	2.21	23	2.59	22	2.59	19	2.46	26	2.71	27		
P	C17. Why we can see the rainbow	2.22	21	1.77	33	2.63	20	2.10	35	2.43	28	2.22	36		
T	E21. New sources of energy from the sun, wind, etc	1.71	36	1.69	35	2.29	34	2.47	27	2.38	29	2.79	21		
E	A14. Dinosaurs, how they lived and why they died out	1.96	27	2.67	9	2.52	25	3.01	7	2.34	30	3.22	5		
S	E29. The landing on the moon & history of space exploration	1.68	37	2.08	29	2.47	28	2.74	13	2.26	31	2.83	20		
N	E37. Famous scientists and their lives	1.57	40	1.82	32	2.09	35	2.28	33	2.21	32	2.60	32		
T	C01. How crude oil is converted to other materials	2.32	17	2.16	25	2.43	29	2.28	32	2.14	33	2.47	33		
B	E25. Plants in my area	1.82	33	1.36	40	2.05	36	1.85	37	2.14	34	2.09	37		
S	A44. Rockets, satellites and space travel	1.64	38	2.24	21	2.35	32	2.80	12	2.12	35	2.98	13		
E	A03. The inside of the earth	1.82	32	1.46	38	1.91	39	1.78	38	2.12	36	2.00	39		
P	E26. Detergents, soaps and how they work	1.85	31	1.64	36	2.04	37	1.76	39	2.08	37	2.09	38		
B	E01. Symmetries and patterns in leaves and flowers	1.54	41	1.44	39	2.04	38	1.56	41	2.08	38	1.72	41		
H	E03. The ozone layer and how it may be affected by humans	1.75	35	1.74	34	2.37	31	2.36	29	2.05	39	2.83	19		
B	A15. How plants grow and reproduce	1.86	29	1.18	41	1.85	41	1.63	40	1.96	40	1.98	40		
T	A47. How petrol and diesel engines work	1.86	30	2.79	6	1.85	40	2.45	28	1.93	41	2.74	24		
	Mean ACE	2.21		2.25		2.61		2.56		2.56		2.76			

Fig 8.2.4: Interest in ACE topics for different book groupings and gender for Primary pupils

8.3 Relative popularity of topics in different subject domains

In §1.4 we described how we classified the topics in Sections A, C and E across the seven subject domains of earth science (E), physical science (P), biological science (B), space (S), technology (T), human focus (H) and nature of science (N). Many topics can map to some degree to more than one such category, but tables (e.g. Fig 8.2.4 above) identify what we judge to be the most relevant category for each topic.

Fig 8.3.1 below shows the mean Likert scores for each subject domain from the full S3 survey (108 topics), and for both the S3 and Primary surveys for the reduced set of 41 topics.

Domain	S3 (108)	S3 (41)	Primary
Technology	2.32	2.34	2.49
Space	2.51	2.53	2.63
Physical science	2.28	2.40	2.51
Nature of science	2.21	2.04	2.41
Human focus	2.55	2.75	2.74
Earth science	2.28	2.44	2.57
Biological science	2.38	2.18	2.36

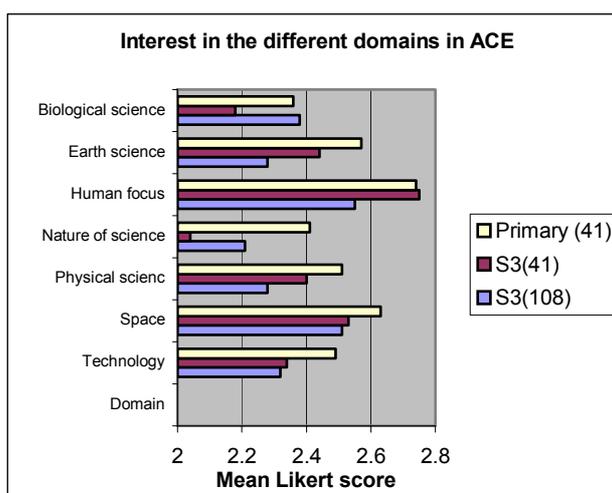


Fig 8.3.1: Mean scores for ACE domains

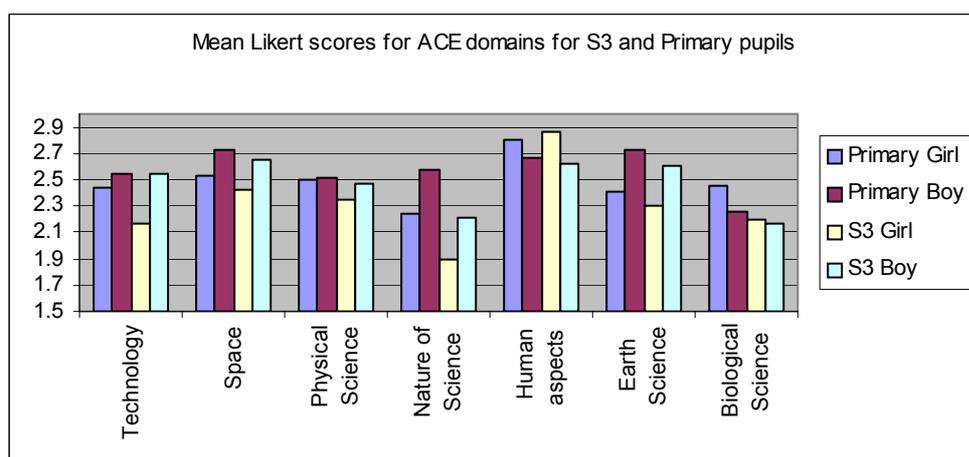
The first point to make is that the specific set of topics selected has a significant effect on the overall interest attracted by a general subject area. The two sets of S3 data follow a broadly similar pattern, though there are significant shifts using the smaller topic list (by as much as 0.20 in two instances) and the rank order changes for the domains ranked 3rd to 6th in popularity. This is both an important qualification, cautioning against sweeping generalisation, and also a message of hope suggesting that unpopular but important subject areas can be approached in ways that will significantly enhance their receptiveness.

Our main objective here is to compare primary and S3 reactions on a like for like basis, and therefore involving the 41 topic data.

- As already noted primary pupils are generally more receptive than S3 pupils, and this is reflected fairly uniformly across the range. The mean score for primaries is above the 'neutral' value of 2.50 in four of the seven domains, compared with only two for S3.
- The single exception is in the human focus domain, the most popular domain for both age groups and the only one in which interest levels are sustained through to S3.
- For both groups space is the second most popular area and, for this selection of topics, earth science comes third and the overall rank order agrees except for 6th and 7th place.
- The most popular topics in each domain tend to remain stable for primary and S3 pupils:
 - technology: *how computers work and how mobile phones can send and receive messages*
 - space: *how it feels to be weightless in space and the possibility of life outside earth*

- physical science: *explosive chemicals*
- human aspects: *dreams and what they mean* and (for S3) *cancer and how to treat it*
- biological science: *brutal and dangerous animals* and (for primary only) *animals in my area* or (for S3 only) *how the human body is built and functions*
- nature of science: *big blunders and mistakes in research and inventions*

Fig 8.3.2 gives a breakdown of the above data by gender, and this reveals an important message.



	Secondary survey 41 questions		Primary survey 41 questions	
	Girl	Boy	Girl	Boy
Technology	2.16	2.54	2.44	2.54
Space	2.42	2.65	2.53	2.73
Physical Science	2.35	2.47	2.50	2.52
Nature of Science	1.90	2.21	2.25	2.57
Human aspects	2.86	2.62	2.81	2.66
Earth Science	2.31	2.60	2.41	2.73
Biological Science	2.20	2.16	2.45	2.26
Mean ACE score	2.31	2.46	2.54	2.57

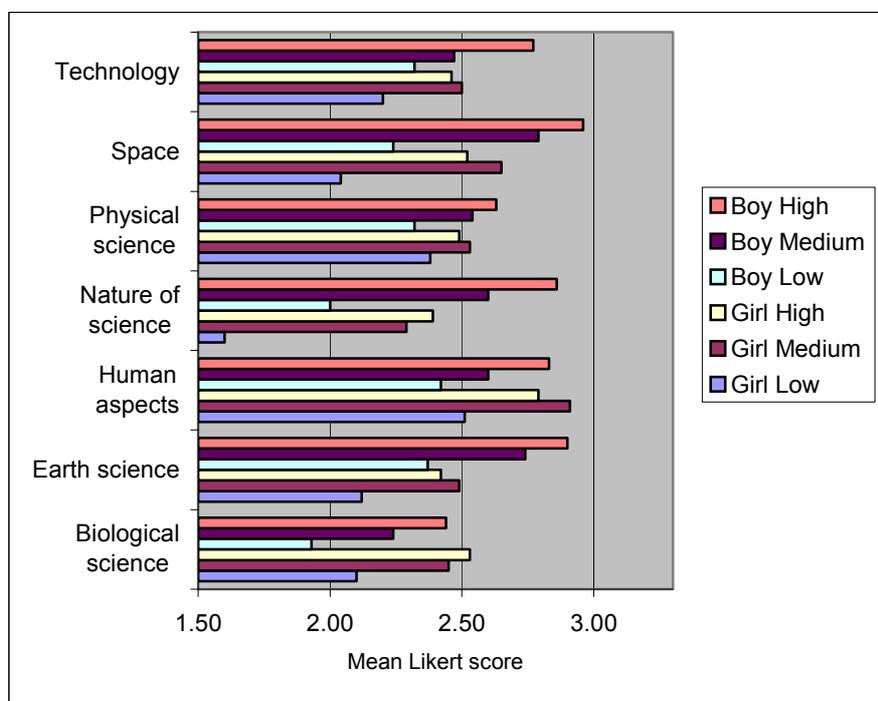
Fig 8.3.2: Gender differences in mean scores for topics in each subject domain

- The sharpest declines in interest, between primary and S3, are for girls, and occurs in technology, physical science and biological science (i.e. in the actual areas of focus for the current secondary school curriculum).
- Girls are not nearly so uninterested in technology at primary level, and this again could suggest that this could be a timely stage for intervention to try to nurture continuing interest.
- Similarly, primary girls seem to be effectively equally as interested as boys in physical science
- Conversely, it is the (small) increase of interest among girls that causes the human aspects domain to be as popular at S3 level as in primary
- The decline in interest among boys, between the primary and S3 surveys, is much smaller and fairly uniform (the single exception being steeply declining interest in the nature of science)
- The divergence between boys and girls grows between primary and S3 both in terms of overall interest and in the types of topics that appeal most or least

In §13 we delve more deeply into the subject preferences revealed, for S3 pupils only, in the full 108 topic survey.

8.4 Influence of book score on interest in different subject domains

Fig 8.4 breaks down the data further to examine differences between book groups



Domain	Girls				Boys				Difference Girl – Boy	
	Low	Med	High	H-L	Low	Med	High	H-L	Low	High
Biological science	2.10	2.45	2.53	0.43	1.93	2.24	2.44	0.51	0.17	0.09
Earth science	2.12	2.49	2.42	0.30	2.37	2.74	2.90	0.53	-0.25	-0.48
Human aspects	2.51	2.91	2.79	0.28	2.42	2.60	2.83	0.41	0.09	-0.04
Nature of science	1.60	2.29	2.39	0.79	2.00	2.60	2.86	0.86	-0.40	-0.47
Physical science	2.38	2.53	2.49	0.11	2.32	2.54	2.63	0.31	0.06	-0.14
Space	2.04	2.65	2.52	0.48	2.24	2.79	2.96	0.72	-0.20	-0.44
Technology	2.20	2.50	2.46	0.26	2.32	2.47	2.77	0.45	-0.12	-0.31

Fig 8.4 Mean Likert scores for primary pupils, by subject domain, books and gender

- The low book group trail in interest for both genders and in all subject domains. The difference is typically about 0.5 on the Likert scale particularly among boys and most extreme for the nature of science domain. These differences are smallest, for both genders, in physical science.
- The interest level for girls is closely similar across the medium and high books groups. This is in contrast with the position among boys where the medium group consistently show significantly less interest than the high books group.
- Space is the most popular area for boys in both high and medium books groups: nonetheless, the variation across the domains for these two groups is quite small, with the sole exception that biological science receives their lowest scores by a fair margin.

- The high books group of primary boys seems very well disposed to technology topics, yet few from this group pursue this interest later. Technology is also the third highest interest category for low books girls.
- Primary girls express slightly higher interest than boys in human aspects and biological science, but they are not far behind in physical science and technology.

8.5 Trends on progression through primary school

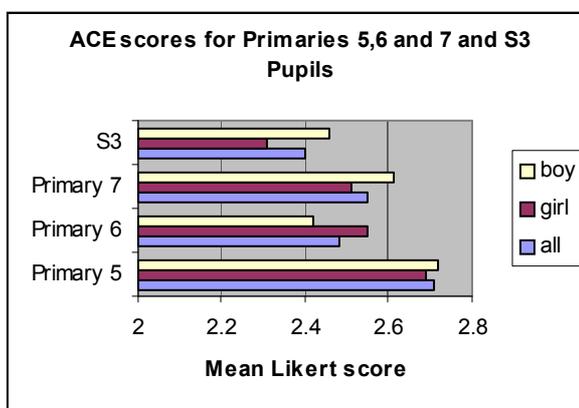
We have already reviewed, in Sec 6 above, some how interest levels varied between the pupils surveyed who were in the P5, P6 and P7 years. Our P5 group was quite small, comprising just 3 class groups and 15% of the total number of pupils surveyed. The P6 group included five class groups, and closer to 30% of all pupils surveyed. Experience from our much larger S3 survey, and evidence from the primary survey itself, as discussed in Sec 7, suggest that there are significant class cohort effects on overall levels of interest. In this survey P5 turn out to be the most interested year group, and P6 the least interested, with an apparent minimum at that level. We think this conclusion is unreliable.

On the other hand all class groups show considerable individual to individual variation in responses to specific topics, and we feel on slightly stronger ground in analysing some internal trends on patterns, such as that examined in §5 for the books impact, which appeared to be growing in impact with age, a trend that appears to have progressed substantially further by the S3 age.

Fig 8.5.1 shows a gender breakdown of overall mean ACE scores.

	Primary 5	Primary 6	Primary 7	S3
All	2.71	2.48	2.55	2.40
Girl	2.69	2.55	2.51	2.31
Boy	2.72	2.42	2.61	2.46

Fig 8.5.1: Mean ACE scores for the different year groups



This data is strongly suggestive of an underlying negative trend of interest on progression through school, and in this the boys group in P6 appears particularly anomalous, representing the only subgroup we have looked at in which the boys are less interested in science than the girls. The overall level of interest among girls does appear to decline monotonically from P5 to S3.

Fig 8.5.2 presents a gender breakdown of P5, P6 and P7 responses of the more popular ACE topics, highlighting each subgroup's 'top ten'.

- The topics favoured by boys seems relatively static, whereas there appears to be somewhat more evolution over these years in the interests of girls. No very clear picture emerges of any consistent pattern of shifting interests.
- Dinosaurs, meteors, earthquakes and unsolved mysteries seem to be largely male interests, while animals, ghosts and witches appeal much more to girls.

Mean ACE scores for pupils in P5, 6 and 7		P5				P6				P7			
		GIRL		BOY		GIRL		BOY		GIRL		BOY	
No in subgroup		26		34		60		62		131		117	
Topic		mLS	rank										
A31. Explosive chemicals	P	2.85	14	3.35	2	2.75	15	3.48	1	3.02	5	3.54	1
A27. Brutal, dangerous and threatening animals	B	3.46	2	3.29	4	3.08	4	2.98	4	3.13	2	3.35	2
C8. The possibility of life outside earth	S	3.28	5	3.12	6	2.87	9	3.19	3	2.69	14	3.28	3
A24. Earthquakes and volcanoes	E	2.62	26	3.41	1	2.80	13	3.21	2	2.80	11	3.05	4
A34. How it feels to be weightless in space	S	2.96	10	3.00	12	2.98	6	2.69	10	2.81	10	3.04	5
A40. How to exercise to keep the body fit and strong	H	2.58	28	3.15	5	3.08	3	2.87	7	2.95	7	3.02	6
A23. How meteors and comets may cause disasters	E	3.12	7	3.12	7	2.48	22	2.75	8	2.41	24	3.02	7
C13. Why we dream and what the dreams may mean	H	3.35	4	3.06	9	3.28	2	2.68	11	3.24	1	2.96	8
A14. Dinosaurs, how they lived and why they died out	E	2.54	29	3.35	3	2.64	19	2.98	6	2.24	31	2.95	9
C10. Unsolved mysteries in outer space	S	2.81	18	3.12	8	2.70	16	2.98	5	2.57	19	2.94	10
E38. Big blunders and mistakes in research and inventions	N	2.96	12	2.94	13	2.37	26	2.67	12	2.37	27	2.92	11
C7. How computers work	T	2.88	13	2.82	19	2.63	20	2.61	16	2.66	15	2.86	12
E12. How alcohol and tobacco might affect the body	H	3.00	9	2.71	25	2.87	10	2.65	14	2.75	13	2.79	13
E07. How to control epidemics and diseases	H	3.19	6	2.82	18	2.63	21	2.21	29	2.66	16	2.77	14
E24. Animals in my area	B	3.42	3	2.76	20	3.39	1	2.37	26	3.10	3	2.77	15
E10. How to perform first-aid & use basic medical equipment	H	2.85	15	2.91	15	2.75	14	2.50	20	3.05	4	2.76	16
A02. Chemicals, their properties and how they react	P	2.81	16	2.76	22	2.25	29	2.52	19	2.61	17	2.74	17
A44. Rockets, satellites and space travel	S	2.65	22	3.03	10	2.22	30	2.63	15	2.08	34	2.71	18
E08. Cancer, what we know and how we can treat it	H	3.50	1	2.59	28	2.81	11	2.56	17	2.95	6	2.68	19
A37. What to eat to keep healthy and fit	H	2.62	27	3.03	11	3.02	5	2.48	21	2.88	8	2.65	20
A47. How petrol and diesel engines work	T	1.73	41	2.29	34	1.78	41	2.53	18	1.93	38	2.64	21
E29. The moon landing and history of space exploration	S	2.48	31	2.74	23	2.38	25	2.66	13	2.18	32	2.60	22
C14. Ghosts and witches, and whether they may exist	H	3.04	8	2.76	21	2.97	7	2.39	25	2.83	9	2.58	23
C06. How mobile phones can send and receive messages	T	2.69	19	2.94	14	2.80	12	2.74	9	2.79	12	2.57	24
C05. How things like radios and televisions work	T	2.42	33	2.62	27	2.48	23	2.47	22	2.48	22	2.57	25
A28. Poisonous plants in my area	B	2.48	30	2.59	29	2.32	27	2.15	33	2.28	30	2.55	26
E14. The possible radiation dangers of mobile phones etc	T	2.96	11	2.26	35	2.88	8	2.40	24	2.60	18	2.50	27

Fig 8.5.2: Mean Likert scores for the ACE topics for P5, P6 and P7, broken by gender

9. Review of Sections B - H

9.1 Comparison of overall responses between S3 pupils and primary pupils

Topic	Primary	S3	Difference	
	Mean	Mean	P - S3	
Section B: My Future Job				
B2. Helping other people	3.07	2.95	0.12	
B3. Working with animals	2.93	2.17	0.76	◆
B7. Working with machines or tools	2.19	2.17	0.01	
B10. Making, designing or inventing something	2.70	2.60	0.10	
B11. Coming up with new ideas	2.70	2.81	-0.11	
B12. Having lots of time for my friends	3.27	3.14	0.13	
B18. Working with something that involves a lot of travelling	2.91	2.37	0.54	◆
B20. Earning lots of money	3.52	3.54	-0.01	
B22. Becoming famous	2.88	2.53	0.35	◆
Section D: Me and the Environmental Challenges				
D1. Threats to the environment are not my business	2.03	2.01	0.02	
D5. I am willing to have environmental problems solved even if this means sacrificing many goods	2.69	2.22	0.47	◆
D8. People worry too much about environmental problems	2.27	2.42	-0.15	—
D16. It is right to use animals in medical experiments if this can save human lives	1.99	2.14	-0.15	—
Section F: My Science Classes				
F2. School science is interesting	2.85	2.80	0.04	
F3. School science is rather easy for me to learn	2.60	2.35	0.25	◆
F5. I like school science better than most other subjects	2.09	2.16	-0.07	
F7. The things that I learn in science at school will be helpful in my everyday life	2.85	2.66	0.18	
F14. I would like to become a scientist	1.63	1.77	-0.14	—
Section G: My Opinions about Science & Technology				
G1. Science and technology are important for society	3.01	2.72	0.29	◆
G2. Science and technology will find cures to diseases such as HIV/AIDS, cancer, etc.	3.26	3.03	0.23	◆
G4. Science and technology make our lives healthier, easier and more comfortable	2.90	2.73	0.17	
G6. The benefits of science are greater than the harmful effects it could have	2.58	2.46	0.12	
G7. Science and technology will help to eradicate poverty and famine in the world	2.52	2.31	0.21	◆
G10. Science and technology are the cause of the environmental problems	2.73	2.29	0.43	◆
G11. A country needs science and technology to become developed	2.54	2.57	-0.02	
G14. We should always trust what scientists have to say	2.30	1.78	0.52	◆
Section H: My out of School Experiences				
H13. watched nature programmes on TV or in a cinema	2.67	2.23	0.44	◆
H17. planted seeds and watched them grow	1.90	2.04	-0.14	—
H31. used a camera	3.56	3.43	0.13	
H32. made a bow and arrow, slingshot, catapult or boomerang	2.02	2.03	-0.01	
H35. made a model such as toy plane or boat etc	2.42	2.10	0.32	◆
H36. used a science kit (like for chemistry, optics or electricity)	2.14	1.92	0.22	◆
H38. recorded on video, DVD or tape recorder	3.11	3.22	-0.12	
H43. used a measuring ruler, tape or stick	3.30	3.16	0.14	
H44. used a mobile phone	3.72	3.70	0.02	
H46. searched the internet for information	3.62	3.67	-0.05	
H47. played computer games	3.69	3.55	0.14	
H50. sent or received e-mail	3.61	3.54	0.07	

Figure 9.1: Comparison of Mean Likert Scores between primary and secondary pupils for Section B

It is notable in Figure 9.1 that the mean scores for primary pupils are generally higher than for S3: the average difference in the last column is +0.14. More often than not this represents a more enthusiastic response to most items. Rather than reiterate much of the fuller

commentary of our previous report, we focus here mainly on questions where the primary responses are significantly different. The table highlights the 13 cases where mean Likert scores for primary are over 0.20 higher than for S3, and the four cases where primary scores most lag those for S3 (difference -0.14 or -0.15).

My Future Job

This Section includes 9 items selected from the 26 of the original study, and 3 are highlighted:

- working with animals is very attractive to the majority of primary pupils, whereas at S3 level this appealed to very few: this item has significantly the largest score difference
- primary pupils were decidedly positive about jobs involving substantial travel whilst the majority of S3 pupils are negatively disposed
- 'becoming famous' is of more interest for primary pupils, though it still is ranked only sixth in importance, whilst 'earning lots of money' remains the top motivator by a fair margin

Me and the Environmental Challenges

Just 4 items were included here, from the original 16 but three reveal significant differences in opinion:

- a substantial majority of S3 pupils were unwilling to contemplate having to 'sacrifice many goods' in order to solve environmental problems, whereas a majority of primary pupils were open to such sacrifices
- the suggestion that 'it is right to use animals in medical experiments if this saves lives,' overwhelmingly opposed in the original survey, is even more strongly rejected by younger pupils
- primary pupils were more concerned that environmental worries were not being taken seriously enough

My Science Classes

The new survey includes 5 of the original 16 items and two of these are highlighted:

- a majority of primary pupils find science 'rather easy for me to learn' whereas most S3 pupils regarded the curriculum at their level as rather more difficult
- even fewer primary pupils 'would like to become a scientist'
- a third point deserves mention, coupling items F2 and F5: in both surveys, a majority report school science as 'interesting', but only very few rate 'like it better than most other subjects', though the primary pupils are somewhat more positive on the first point but somewhat more negative on the second.
- This last conclusion came somewhat as a surprise, though it is in line with the earlier responses of S3 pupils that were strongly negative about their previous primary science experience. It had been suggested, however, that the S3 response reflected experience of primary science prior to 2003, and there were grounds to expect that more recent developments in the delivery of primary science might generate a significantly improved response. Sadly we did not find this to be the case, even for a sample composed exclusively of classes that had been taken to science centres.

My opinions about Science & Technology

Here 8 of the original 16 items were included and no fewer than five of these show significant differences in attitudes. In each case primary pupils demonstrate more positive views and attitudes towards science (although for G10 agreement shows a more negative view of science!)

- we would suggest that a single main conclusion be drawn from this section, namely that priority should be given to highlighting science **issues** at primary level and beyond, in an attempt to reinforce positive attitudes and to hope to stem the significant negative shift that seems to occur in the early teenage years: the significance and value of science to modern society requires attention in addition to simply exploring science concepts and traditional curricular topics

My out of School Experiences

This area was sampled using 12 of the 61 items from the original survey

- questions in this section ask: 'How often have you done this outside School?' with responses ranging from 'never' to 'often': quite surprisingly, the average score across the items selected is slightly higher in the primary pupils' returns than it was for S3 pupils - for instance primary pupils report a significantly greater level of experience in making models and using science kits (perhaps S3 pupils tend to feel they have outgrown such interests)
- primary pupils seem to be as engaged in the use of 'modern' technology as secondary pupils: their use of mobile phones, cameras, DVDs and computers is reportedly similar
- they appear significantly more engaged in watching nature programmes

9.2 Gender differences in Sections B - H

Fig 9.2 breaks down the responses by gender for both the Primary and the S3 groups. Having given a quite full description of gender differences at S3 level in our earlier Report, and by and large the direction and scale of these differences are rather similar in the primary survey. There are only three cases where the mean score change for girls and boys, on going from primary to S3, differs by more than 0.20 (see the last 2 columns of Fig 9.2):

- we have already noted that 'working with animals' appeals to a strong majority of primary pupils but only to a small minority by S3 stage: however both the extent of this early attraction, and the extent by which it declines with age is much greater among girls
- whilst both girls and boys in primary are quite attracted towards 'making, designing or inventing something', interest among girls drops sharply by S3 stage, whilst boys become marginally more positive
- girls find their science studies easier to learn than do boys at primary stage, but this difference is dramatically reversed among S3 pupils

The latter two of these points give yet further examples where the gender imbalances that cause concern at later ages are much smaller or non-existent at the primary stage. We noted earlier that at primary girls were less averse to learning about 'technology' topics than secondary girls. However, item B7 reveals that this is not at all true with regard to 'working with machines or tools'.

	PRIMARY pupils			S3 pupils			CHANGE	
			g-b			g-b	P - S	P - S
	Girl	Boy	Diff	Girl	Boy	Diff	Girls	Boys
	Mean							
B2. Helping other people	3.23	2.90	0.33	3.18	2.70	0.49	0.05	0.21
B3. Working with animals	3.20	2.65	0.55	2.31	2.00	0.31	0.89	0.65
B7. Working with machines or tools	1.70	2.68	-0.98	1.63	2.77	-1.14	0.07	-0.09
B10. Making, designing or inventing something	2.71	2.68	0.02	2.48	2.73	-0.25	0.23	-0.05
B11. Coming up with new ideas	2.64	2.75	-0.10	2.74	2.89	-0.15	-0.09	-0.14
B12. Having lots of time for my friends	3.38	3.15	0.22	3.18	3.10	0.08	0.20	0.05
B18. Working with something that involves a lot of travelling	2.88	2.94	-0.06	2.31	2.44	-0.13	0.57	0.50
B20. Earning lots of money	3.50	3.55	-0.05	3.46	3.62	-0.16	0.03	-0.07
B22. Becoming famous	2.72	3.04	-0.33	2.41	2.67	-0.25	0.30	0.38
D1. Threats to the environment are not my business	1.96	2.10	-0.14	1.94	2.08	-0.14	0.02	0.02
D5. I am willing to have enviro probs solved even if this means giving up goods	2.67	2.71	-0.04	2.22	2.22	0.00	0.45	0.49
D8. People worry too much about environmental problems	2.14	2.41	-0.27	2.32	2.53	-0.21	-0.18	-0.12
D16. It is right to use animals in medical expts if this can save human lives	1.83	2.14	-0.31	1.97	2.33	-0.36	-0.14	-0.19
F2. School science is interesting	2.85	2.84	0.01	2.75	2.87	-0.12	0.10	-0.03
F3. School science is rather easy for me to learn	2.70	2.50	0.20	2.28	2.43	-0.15	0.42	0.07
F5. I like school science better than most other subjects	1.97	2.21	-0.24	2.06	2.28	-0.22	-0.09	-0.07
F7. The things that I learn in science at school will be helpful in my everyday life	2.84	2.85	-0.01	2.65	2.68	-0.03	0.19	0.17
F14. I would like to become a scientist	1.53	1.74	-0.21	1.63	1.92	-0.29	-0.10	-0.18
G1. Science and technology are important for society	2.91	3.11	-0.21	2.65	2.80	-0.14	0.26	0.32
G2. S & T will find cures to diseases such as HIV/AIDS, cancer, etc.	3.24	3.29	-0.05	3.05	3.01	0.04	0.19	0.28
G4. S & T make our lives healthier, easier and more comfortable	2.84	2.96	-0.11	2.67	2.79	-0.12	0.17	0.17
G6. The benefits of science are greater than the harmful effects it could have	2.50	2.66	-0.16	2.38	2.55	-0.17	0.12	0.11
G7. S & T will help to eradicate poverty and famine in the world	2.49	2.56	-0.07	2.29	2.34	-0.05	0.20	0.22
G10. Science and technology are the cause of the environmental problems	2.68	2.77	-0.08	2.28	2.31	-0.03	0.41	0.46
G11. A country needs science and technology to become developed	2.44	2.65	-0.21	2.48	2.66	-0.18	-0.04	-0.02
G14. We should always trust what scientists have to say	2.26	2.34	-0.07	1.74	1.83	-0.09	0.53	0.51
H13. watched nature programmes on TV or in a cinema	2.69	2.65	0.04	2.2	2.27	-0.07	0.49	0.38
H17. planted seeds and watched them grow	2.04	1.76	0.28	2.16	1.90	0.26	-0.12	-0.14
H31. used a camera	3.67	3.46	0.21	3.59	3.25	0.34	0.08	0.21
H32. made a bow and arrow, slingshot, catapult or boomerang	1.62	2.42	-0.79	1.74	2.37	-0.63	-0.12	0.05
H35. made a model such as toy plane or boat etc	2.19	2.64	-0.45	1.85	2.39	-0.54	0.34	0.25
H36. used a science kit (like for chemistry, optics or electricity)	1.99	2.30	-0.32	1.81	2.05	-0.24	0.18	0.25
H38. recorded on video, DVD or tape recorder	3.23	2.98	0.25	3.28	3.17	0.11	-0.05	-0.19
H43. used a measuring ruler, tape or stick	3.35	3.24	0.11	3.22	3.09	0.13	0.13	0.15
H44. used a mobile phone	3.81	3.63	0.18	3.81	3.58	0.23	0.00	0.05
H46. searched the internet for information	3.68	3.56	0.12	3.75	3.59	0.16	-0.07	-0.03
H47. played computer games	3.59	3.79	-0.20	3.48	3.63	-0.15	0.11	0.16
H50. sent or received e-mail	3.64	3.58	0.06	3.66	3.41	0.25	-0.02	0.17

Fig 9.2: Differences in interests between primary and S3 pupils for Sections B - H

9.3 Number of Books in the Home and Sections B - H

Fig 9.3 breaks down the responses, from primary pupils only, by books in the home and then also by gender. There is a lot of information in this Table that a reader with a specific issue in mind might find useful. In this commentary we will concentrate mainly on columns 2-5 summarising the breakdown by books alone, using the Low, Medium and High groupings defined earlier. There are as usual some very large effects and these are highlighted in the final column where 'x' or 'xx' reflect score differences in column 5 in excess of 0.20 or 0.40 respectively.

My Future Job

- Pupils from homes with many books were keener to help others, work with animals, design and invent things as well as come up with new ideas.
- 'Making lots of money', whilst the highest regarded priority for all, was particularly dominant among the lower books groups.
- 'Becoming famous' was a much stronger motivation for pupils from homes with few books (3rd in rank order on their Sec B list as opposed to 2nd last for those with many books).

Me and the Environmental Challenges

- High book pupils are much more prepared to sacrifice goods for the sake of the environment with a Likert score of 2.90
- Low book pupils are more inclined to think that people worry too much about environmental problems and more agree with the statement *Threats to the environment are not my business*.
- One case where there is almost no books effect is perhaps worth noting: all groups are almost equally strongly opposed to animal testing

My Science Classes

- High book pupils are, in relative terms, more in agreement with all the questions in this section, although the score for *I would like to be a scientist* is still very negative at 1.75.

My Opinions about Science and Technology

- Generally across this section the High books group agreed in a more positive fashion with all statements, the only exception being to *We should always trust what scientists say* where they were slightly more strongly in disagreement than the other groups. This mirrors findings in our S3 study: scepticism on this score is already becoming established at primary age.
- Notwithstanding the above point that High books pupils are generally more positive, this is the section where differences by books is smallest, as reflected by the relatively low density of x's attributed in the final column of the Table.

My out of School Experiences

Responses can be divided into three categories in this section

- Those where responses for all groups were similar: use of cameras, videos and DVDs, measuring things and searching the internet.

- Activities where the Low book pupils scored higher than the High book pupils were: use of mobile phone, playing computer games and sending email.
- In all the questions mentioning hobbies or watching nature programmes on TV the High book score pupils scored significantly higher.

It appears that in homes where there are few books pupils are even more into modern technology while those in homes where there are many books more traditional hobbies have a higher priority.

9.4 Gender differences within the different books groups

As indicated above we will limit our commentary on columns 6-13 in Table 7.3. In the following cases there are particularly large differences between primary boys and girls in the 'books influence'.

- Boys from Low books homes are much less interested than any of the other sub-groups in work involving 'helping other people' or 'making, designing or inventing something'.
- The same sub-group (Low books boys) also disagree significantly more strongly than any other sub-group with the statements 'school science is easy for me to learn' and 'I like school science better than most other subjects'. For the second of these statements the second most negative sub-group is, by contrast, High books girls.
- In terms of watching nature programmes, planting seeds and using science kits the increase in popularity among higher books groups is much stronger among boys than for girls.

Gender					girl	boy	girl	boy	girl	boy			
Book category	Low	Medium	High	Differ	Low	Low	Medium	Medium	High	High	g1-g3	b1-b3	
Topic/ Number in group	67	184	161	L-H	28	37	95	89	88	75			
B02. Helping other people	2.75	3.11	3.12	-0.37	3.11	2.49	3.25	2.97	3.26	2.97	-0.15	-0.49	X
B03. Working with animals	2.46	2.96	3.06	-0.59	2.79	2.22	3.26	2.64	3.26	2.81	-0.48	-0.60	XX
B07. Working with machines or tools	2.08	2.13	2.25	-0.17	1.57	2.46	1.56	2.75	1.85	2.71	-0.28	-0.25	
B10. Making, designing or inventing something	2.49	2.62	2.84	-0.35	2.75	2.30	2.59	2.65	2.83	2.85	-0.08	-0.55	X
B11. Coming up with new ideas	2.20	2.65	2.92	-0.72	2.07	2.30	2.66	2.64	2.80	3.05	-0.73	-0.76	XX
B12. Having lots of time for my friends	3.34	3.27	3.22	0.11	3.57	3.16	3.33	3.22	3.37	3.05	0.20	0.11	
B18. Working with something that involves a lot of travelling	2.82	2.98	2.86	-0.05	3.00	2.68	2.92	3.06	2.80	2.93	0.20	-0.26	
B20. Earning lots of money	3.78	3.60	3.34	0.45	3.75	3.81	3.56	3.63	3.33	3.35	0.42	0.46	XX
B22. Becoming famous	3.12	2.98	2.70	0.42	3.00	3.22	2.79	3.19	2.53	2.89	0.47	0.32	XX
D01. Threats to the environment are not my business	2.33	2.03	1.90	0.43	2.29	2.37	1.95	2.11	1.84	1.97	0.45	0.40	XX
D05. I am willing to have envir probis solved even if this means giving up many goods	2.20	2.67	2.90	-0.70	2.14	2.24	2.67	2.67	2.82	2.99	-0.67	-0.75	XX
D08. People worry too much about environmental problems	2.56	2.40	1.99	0.57	2.43	2.66	2.22	2.60	1.93	2.05	0.50	0.60	XX
D16. It is right to use animals in medical experiments if this can save human lives	1.97	1.93	2.02	-0.05	1.93	2.00	1.77	2.10	1.89	2.19	0.04	-0.19	
F02. School science is interesting	2.61	2.90	2.85	-0.24	2.71	2.54	2.89	2.91	2.83	2.88	-0.11	-0.34	X
F03. School science is rather easy for me to learn	2.37	2.64	2.64	-0.27	2.64	2.18	2.74	2.53	2.64	2.64	0.00	-0.46	X
F05. I like school science better than most other subjects	1.89	2.16	2.07	-0.17	2.07	1.77	1.99	2.34	1.91	2.26	0.17	-0.49	
F07. The things that I learn in science at school will be helpful in my everyday life	2.58	2.92	2.87	-0.29	2.50	2.64	2.91	2.93	2.89	2.84	-0.39	-0.20	X
F14. I would like to become a scientist	1.40	1.57	1.75	-0.34	1.25	1.51	1.48	1.67	1.64	1.86	-0.39	-0.35	X
G01. Science and technology are important for society	2.79	3.02	3.09	-0.30	2.64	2.90	2.94	3.11	2.98	3.22	-0.33	-0.32	X
G02. Science and technology will find cures to diseases, HIV/AIDS, cancer	3.07	3.28	3.32	-0.24	3.11	3.05	3.24	3.33	3.26	3.38	-0.16	-0.33	X
G04. Science and technology make our lives healthier, easier and more comfortable	2.72	2.97	2.88	-0.16	2.75	2.69	2.86	3.09	2.85	2.92	-0.10	-0.23	
G06. The benefits of science are greater than the harmful effects it could have	2.39	2.65	2.57	-0.19	2.50	2.31	2.52	2.79	2.48	2.68	0.02	-0.38	
G07. Science and technology will help to eradicate poverty and famine in the world	2.23	2.54	2.60	-0.37	2.37	2.13	2.35	2.74	2.64	2.54	-0.27	-0.41	X
G10. Science and technology are the cause of the environmental problems	2.69	2.70	2.76	-0.08	2.68	2.69	2.64	2.75	2.72	2.81	-0.04	-0.12	
G11. A country needs science and technology to become developed	2.45	2.56	2.54	-0.09	2.46	2.45	2.40	2.73	2.45	2.65	0.02	-0.20	
G14. We should always trust what scientists have to say	2.34	2.32	2.23	0.11	2.38	2.31	2.26	2.38	2.22	2.23	0.16	0.08	
H13. watched nature programmes on TV or in a cinema	2.12	2.67	2.89	-0.77	2.29	2.00	2.67	2.67	2.84	2.95	-0.56	-0.95	XX
H17. planted seeds and watched them grow	1.41	1.85	2.15	-0.74	1.74	1.18	2.02	1.67	2.14	2.16	-0.40	-0.98	XX
H31. used a camera	3.48	3.58	3.57	-0.10	3.68	3.33	3.75	3.40	3.58	3.57	0.10	-0.23	
H32. made a bow and arrow, slingshot, catapult or boomerang	1.82	1.91	2.18	-0.36	1.25	2.23	1.59	2.25	1.76	2.68	-0.51	-0.45	X
H35. made a model such as toy plane or boat etc	2.09	2.41	2.52	-0.43	1.93	2.21	2.18	2.65	2.27	2.80	-0.34	-0.59	XX
H36. used a science kit (like for chemistry, optics or electricity)	1.84	2.10	2.26	-0.43	1.89	1.79	2.02	2.18	1.97	2.61	-0.07	-0.82	XX
H38. recorded on video, DVD or tape recorder	3.03	3.05	3.20	-0.17	3.32	2.82	3.25	2.85	3.19	3.20	0.13	-0.38	
H43. used a measuring ruler, tape or stick	3.18	3.34	3.30	-0.12	3.14	3.21	3.42	3.25	3.34	3.25	-0.20	-0.05	
H44. used a mobile phone	3.90	3.77	3.58	0.31	4.00	3.82	3.90	3.63	3.65	3.51	0.35	0.31	X
H46. searched the internet for information	3.60	3.60	3.65	-0.05	3.79	3.46	3.68	3.52	3.66	3.64	0.13	-0.17	
H47. played computer games	3.96	3.74	3.52	0.43	3.96	3.95	3.61	3.87	3.47	3.59	0.50	0.36	XX
H50. sent or received e-mail	3.83	3.73	3.39	0.44	3.86	3.80	3.77	3.68	3.44	3.33	0.42	0.47	XX

Figure 9.3: Pupil responses for sections B-H classified according to books in the home and then gender

10. Section I: What do scientists do?

This Section substitutes the single open response question *Myself as a Scientist* in the original ROSE survey. Primary pupils have a much more limited experience of science education and we did not think it sensible to duplicate that exercise. Instead, we substituted a section entitled *What do scientists do?* Here we asked pupils to write down three jobs in which they thought the person doing the job needed to know lots of science. Then we also asked *What do you want to be when you are grown up?*

In retrospect, we did not phrase the first of these two question clearly enough, for many pupils did not list jobs but what they thought scientists did and the personal attributes they needed to have. Many wrote that you had to be clever, honest and hard working to be a scientist and others said that they conducted experiments, did tests on animals and also blew things up.

Fig 10.1 lists the job titles suggested, in order of the frequency with which they were identified. As can be seen the most frequently named jobs were doctors, 'scientists', teachers, vets, astronauts, chemists, engineers etc. Some less mainstream occupations also got a mention such as a patent agent, a perfumier and palaeontologist. However, there were also multiple nominations of mechanics, nurses, electricians, chefs, policemen, footballers and hairdressers.

What do you want to be when you are grown up?

It was very notable that only three pupils said that they wanted to be 'scientists'. Four wanted to be marine biologists although they did not seem to consider this to be a science related career as in the section on school science none of the four entered a score of more than 2 in reply to the question *I want to be a scientist*.

There was a large diversity of possible careers given in answer to this question. Careers mentioned tended to be gender typical in spite modern trends towards equality. For boys the most popular career was footballer and for girls it was to become a vet, actress or hairdresser. Only 9 occupations had responses in double figures, as listed in Fig 10.2. Most popular by some margin were sports careers (78) including football. Mention was also made of golf, rugby, snooker, motoX, race driving, wrestling, karate, basketball, badminton, and athletics.

Second in popularity came careers involved with animals in some capacity other than being a vet. Fifty five pupils in total wanted to work with animals whereas only seventeen wanted to be involved in 'human' medicine. Becoming an RSPCA officer was a surprisingly popular choice although three of the six replies came from the one school. Others mentioned working in a zoo, working with dogs and horses and also cats and one pupil wanted to be a pet sitter. Some mentioned what they wanted from a career rather than an actual job, one boy wanted to become the owner of a big company, another wanted to become a billionaire while another more modestly just wanted to earn lots of money. One girl said rather touchingly that she wanted to be just like her mum! Only three wanted to join the armed forces - one to the army and two to the air force.

Secondary school pupils were not asked a corresponding question, but it should be noted that the replies perhaps reflect again the finding that primary pupils appear to be much more interested in animals than secondary school pupils and to show less interest in medical matters. In total there were over 115 different career titles nominated.

Occupation	No of responses	Occupation	No of responses
Doctor	93	Lab assistant	3
Scientist	62	Geologist	2
Teacher (science)	62	Museum worker	2
Vet	33	Naturist	2
Astronaut	32	Vulcanologist	2
Chemist	30	ict/it	2
Engineer	22	Animal testing	2
Mechanic	17	Architect	1
Inventor	16	Astrophysics	1
Astronomer	12	Biochemist	1
Nurse	11	Council worker	1
Researcher	11	Electronic	1
Biologist	10	Explorer	1
Electrician	10	Fireman	1
Physicist	10	Gardener	1
Chef	9	Joiner	1
Dentist	8	Marine biologist	1
Pharmacist	8	Mathematician	1
Forensic	8	Meteorologist	1
Computer person	6	Naturalist	1
Weather man	6	Palaeontologist	1
Policeman	5	Patent agent	1
Technician	5	Perfumier	1
Archaeologist	4	Pilot	1
Footballer	4	Radiographer	1
Hairdresser	4	Rocket builder	1
Paramedic	4	Sports trainer	1
Plumber	4		
Surgeon	4		

Fig 10.1: Jobs nominated as involving a need to know lots of science

Occupation	Number
Sportsman	78
Animal welfare	55
Artistic (singer/ actor/ DJ etc)	42
Medical and related	17
Hairdresser	15
Police	12
Scientist (marine biologist, palaeontologist, astronomer, etc)	12
Teacher	11
Legal	11
Engineer	9
Mechanic	9
Joiner	7
Model	7
Farmer	4

Fig 10.2: Most popular nominated career ambition

11. Pupil interests versus their liking for school science and their out-of-school activities - Primary survey

Question F05 in the survey asked pupils whether they 'like science better than most other subjects'. In Fig 11.1 we analyse pupils' scores for each of the ACE topics depending on their response to that item.

Item F05: I like science better than most other subjects,		Strong disagree		Disagree		Agree		Strong agree		Diff	
Number in Group		130		166		76		46		4 - 1	
Domain	Topic/	mean	rank	mean	rank	mean	rank	mean	rank		
P	A31. Explosive chemicals	3.13	2	3.07	3	3.37	1	3.62	1	-0.49	
S	C08. The possibility of life outside earth	2.88	5	3.01	5	3.16	4	3.26	2	-0.38	
H	E08. Cancer, what we know and how we can treat it	2.53	16	2.91	7	2.83	16	3.17	3	-0.64	↓
S	A34. How it feels to be weightless in space	2.83	8	2.80	14	3.11	6	3.17	4	-0.34	
N	E38. Big blunders and mistakes in research and inventions	2.38	21	2.62	21	2.88	14	3.17	5	-0.80	↓
H	C13. Why we dream and what dreams may mean	2.92	4	3.18	2	3.12	5	3.13	6	-0.21	◆
H	A40. How to exercise to keep the body fit and strong	2.98	3	2.88	9	3.07	7	3.13	7	-0.15	◆
B	A27. Brutal, dangerous and threatening animals	3.22	1	3.19	1	3.20	2	3.11	8	0.11	◆
T	C07. How computers work	2.67	12	2.62	20	2.75	20	3.11	9	-0.44	
P	A02. Chemicals, their properties and how they react	2.44	20	2.49	24	2.79	18	3.07	10	-0.63	↓
	E07. How to control epidemics and diseases	2.21	28	2.81	12	2.93	13	3.07	11	-0.86	↓
E	A23. How meteors and comets may cause disasters	2.48	18	2.73	16	2.97	9	3.07	12	-0.58	
	E29. The landing on the moon and history of space exploration	2.22	27	2.34	32	2.75	21	3.04	13	-0.83	↓
S	C10. Unsolved mysteries in outer space	2.62	14	2.80	13	3.05	8	3.02	14	-0.41	
	E12. How alcohol and tobacco might affect the body	2.68	11	2.76	15	2.84	15	3.00	15	-0.32	
E	A24. Earthquakes and volcanoes	2.87	6	2.89	8	3.20	3	2.98	16	-0.11	◆
H	E10. How to perform first-aid & use basic medical equipment	2.64	13	2.93	6	2.96	10	2.89	17	-0.25	◆
T	C06. How mobile phones can send and receive messages	2.75	9	2.64	19	2.77	19	2.85	18	-0.09	◆
	A14. Dinosaurs, how they lived and why they died out	2.59	15	2.72	17	2.75	22	2.85	19	-0.26	
	A44. Rockets, satellites and space travel	2.22	25	2.39	29	2.75	23	2.85	20	-0.62	↓
	E37. Famous scientists and their lives	1.91	36	2.12	35	2.29	35	2.85	21	-0.93	↓
	C01. How crude oil is converted to other materials	2.28	23	2.19	34	2.45	34	2.80	22	-0.53	
	E14. The possible radiation dangers of mobile phones	2.31	22	2.68	18	2.63	25	2.78	23	-0.47	
	C05. How things like radios and televisions work	2.52	17	2.40	27	2.55	31	2.76	24	-0.24	
	A47. How petrol and diesel engines work	2.22	26	2.08	36	2.12	37	2.74	25	-0.52	
	E04. The greenhouse effect and how it may be changed	2.17	30	2.56	22	2.64	24	2.72	26	-0.55	
H	A37. What to eat to keep healthy and fit	2.73	10	2.81	11	2.80	17	2.70	27	0.03	◆
	A07. How the human body is built and functions	2.26	24	2.40	28	2.61	26	2.70	28	-0.43	
B	E24. Animals in my area	2.84	7	3.05	4	2.95	12	2.67	29	0.16	◆
H	C14. Ghosts and witches, and whether they may exist	2.46	19	2.87	10	2.95	11	2.63	30	-0.17	
	E03. The ozone layer and how it may be affected by humans	2.01	35	2.28	33	2.56	30	2.63	31	-0.62	↓
	A28. Poisonous plants in my area	2.19	29	2.41	25	2.47	33	2.63	32	-0.44	
	E21. New sources of energy from the sun, wind,	2.07	32	2.40	26	2.58	27	2.63	33	-0.56	
	A01. Stars, planets and the universe	2.15	31	2.51	23	2.58	28	2.61	34	-0.45	
	C16. Why the stars twinkle and the sky is blue	2.07	33	2.35	31	2.57	29	2.48	35	-0.41	
	C17. Why we can see the rainbow	2.05	34	2.36	30	2.50	32	2.46	36	-0.40	
	E25. Plants in my area	1.80	38	1.99	37	2.14	36	2.09	37	-0.29	
	A03. The inside of the earth	1.72	39	1.92	39	1.96	41	1.91	38	-0.19	
	E01. Symmetries and patterns in leaves and flowers	1.62	41	1.82	41	1.96	40	1.87	39	-0.25	
	E26. Detergents, soaps and how they work	1.84	37	1.95	38	2.09	38	1.84	40	-0.01	
	A15. How plants grow and reproduce	1.64	40	1.84	40	2.03	39	1.80	41	-0.17	
	Mean Likert score for ACE	2.39		2.55		2.70		2.78		-0.38	

Fig 11.1: Mean ACE scores for those who like/do not like science better than most other subjects

The first point to note from this analysis is the rather self evident one that the mean ACE score rises steadily and significantly with more positive relative liking for the subject of science at school.

On the other hand there is significant variation in the trends for different topics. The right hand column of the Table gives the mean Likert score differences between the most negative and the most positive groups for each item, and these values vary enormously from +0.16 to -0.93. (Note that in a small number of cases the most extreme scores are from one of the middle groups.)

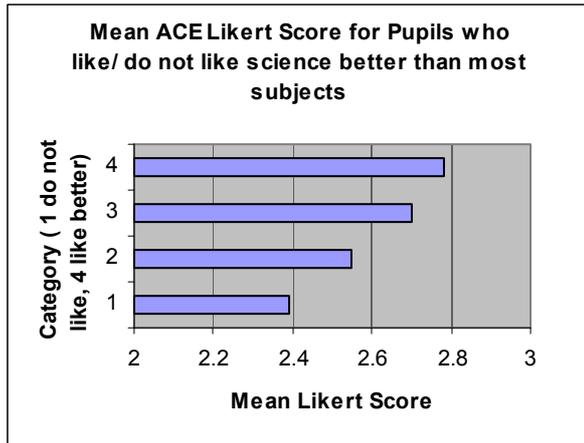


Fig 11.2: Mean ACE score vs response to F05

- In the Table symbol ♦ flags items which achieve a positive mean score (>2.50) from all groups where the popularity fall least across the groups. In order of decreasing mean score for the most negative group these relate to dangerous animals, exercise for fitness, dreams, earthquakes & volcanoes, local animals, how mobile phones work, eating for health, and applying first aid & basic medical equipment.
- On the other hand, symbol ↓ flags those items whose appeal falls off most dramatically for those less enamoured by the subject of science at school. Starting with the most dramatic case these relate to famous scientists, control of epidemics & diseases, moon & space exploration, blunders in research, cancer and its treatment, chemical properties & reactions, rockets & satellites, and the ozone layer.
- We would characterise the characteristic difference between these two lists as reflecting a stronger relative interest in the dramatic and personally useful topics among those less attracted to school science, versus much enhanced interest in a deeper understanding of scientific knowledge and progress among those rating the subject more highly.
- One disappointing aspect of this survey is the small number of pupils who like school science better than most subjects, with just over 10% rating the subject highly.

12. Further results from the 2005/06 survey of S3 pupils: Perceptions of ACE

We were aware, after our initial survey of S3 pupils that much further work could be done using our spreadsheet and in discussions with science centres we were asked to carry out a further analysis of our original survey.

In our previous survey we had divided the 108 ACE topics into different categories or domains but had not really looked at popularity of topics within domains and so we first had a brief look at this.

The results of our efforts are given below.

12.1 ACE Subdivisions in S3 ROSE Survey

The most and least popular topics in the ROSE questionnaire have been found and the popularity of the different classifications identified⁷. Topics involving human interest and space being most popular and the nature of science topics being least popular amongst pupils. When gender is considered human interest and biology topics are of more interest to girls and space and technology are the preferred options for boys.

We decided to unravel this a bit further and look at preferences within the different classifications to see what picture emerged. For the complete table of Likert scores for all 108 topics go to Appendix 3.

Technology (16 questions)

The top three technology items for boys are: how the atomic bomb functions, how computers work and how to use and repair everyday objects.

What most interests girls in technology is quite different. Their top three are: how x-rays and ultrasound are used in medicine, how mobile phones work and the dangers involved with these phones. Next on their list is how computers work. Both rate how CDs and DVDs store and play music at fifth, with fourth for boys being how motor engines work.

At the other end of the list both boys and girls show a distinct lack of interest in how crude oil is converted into other materials. Girls are also not interested in how a nuclear power plant functions whereas boys are not interested in optical instruments.

Overall it should be noted that interest rate in technology is not high apart from the top two for boys where the Likert scores are both over 2.90, with girls the highest score hovers at the 50% interest region of 2.50 dropping to 1.6 for their least favourite topic.

Space (9 questions)

The top 2 here for both are the same, how it feels to be weightless in space and the possibility of life outside earth. These are the two space topics which show the human dimension which appears to make an item more popular.

What least interests girls in this section is different from the boys and is quite surprising they rate rockets, satellites and space travel least with a Likert score of only 2.00 and next is the *first landing on the moon and history of space exploration*. Boys are more interested in these topics and show least interest in the two more mundane questions namely *why the stars twinkle and the sky is blue* and *how to navigate by the stars*.

Physical sciences (11 questions)

Only one question gives a significantly high Likert score here, namely *Explosive chemicals*, and this is much higher for boys than girls although it is the most popular topic for both. Apart from this the interests of boys and girls are quite different. Girls appear more interested in

⁷ The ROSE Survey in Scotland - An Initial Report, August 2006, S Farmer, M Finlayson, B Kibble and A Roach, report available at <http://www.gla.ac.uk/stem>

light and what can be seen than boys who are more interested in chemicals and electricity. Neither group expresses much interest in sound or musical instruments.

Atoms and molecules and *soaps and detergents* are unpopular topics with both.

The nature of science (8 questions)

Interest in this section is low for girls in particular and with only three of the questions giving scores of over 2.5 for the boys. Ratings for both boys and girls are very similar, with the top four and the least popular topic being identical. Their most popular topic is, ironically, *phenomena that scientists still cannot explain*, followed by *discoveries that have changed the world* and *recent inventions and discoveries in science and technology*. The least popular topic here has already been identified as unpopular namely *famous scientists and their lives*.

I suppose that it is encouraging to know that whilst pupils express no interest in the scientists themselves they show interest in their discoveries and inventions.

Human Issues (23 questions)

Here the top 10 are fairly similar for both groups with girls having a greater interest in mystical and metaphysical topics than boys (C13, C11, C14 and C15). For boys the most popular topic is *The effect of electric shocks and lightning on the body*, which is 18th on the girls list. Girls show more interest in plastic surgery, anorexia, lotions and creams and alternative therapies than boys.

Neither group show much interest in the interdependence of people, plants, animals and the environment, the ozone layer, the greenhouse effect or how to handle waste and garbage. Girls are least interested in how electricity has affected the development of our society.

Earth Science (11 questions)

Here boys are most interested in violent and exciting events such as tornados, earthquakes and meteors hitting earth as well as dinosaurs. Girls also rate these topics fairly highly but show most interest in gems and crystals. Neither group shows any interest in farming methods or organic farming.

Biology (23 questions)

Categorising topics in this way shows very markedly pupil disinterest in plants. The eight items at the foot of the popularity list are all related to plants. Pupils, as a whole, do not even show much interest in the medicinal use of plants.

Boys again show their interest in topics which are violent and dangerous (A32 and A27), also in animal cloning and how animals use colours to hide, while girls are more interested in the human body, babies and abortion. Girls' number one interest here is *how to protect endangered species of animals*.

12.2 How interest in ACE topics may be influenced by other factors

We also wanted to investigate how interest in ACE topics varied with interest in science at school, qualifications being studied and also to see if visits to science centres had an effect.

To investigate this we selected four topics in Section F:

F01 *school science is difficult for me*

F02 *school science is interesting*

F05 *I like school science better than most subjects*

F14 *I want to be a scientist*

We then calculated the mean ACE score for each of the four responses to each topic and looked at the results which are given in the sections below.

The same technique was used for the responses to topic H09 *I have visited a science centre or museum*.

First we will look to see whether pupils who find science difficult have less interest in science topics and also if they have different interests.

To find the answer to this question we split the results for F01: *School science is difficult for me* into the four categories and also gender (4 is for those who agree that school science is difficult and 1 is for those who do not agree with the statement). As can be seen from Mean ACE scores at the foot of Table 12.2.1 below there is no meaningful correlation of interest in science with finding science easy or difficult.

		Number in group		356		536	371	178		335		451	330	148	
		Girl						Boy							
Topic	F01 School science is easy (1) to difficult(4) for me	1	rank	2	3	4	rank	1	rank	2	3	4	rank		
A34	S How it feels to be weightless in space	2.87	7	3.05	3.11	2.98	10	3.24	2	3.18	3.17	3.12	1		
C13	H Why we dream and what dreams mean	3.13	2	3.35	3.36	3.43	1	2.88	14	2.79	2.96	3.11	2		
A31	P Explosive chemicals	2.82	11	2.75	2.65	2.52	34	3.43	1	3.35	3.25	3.09	3		
A40	H How to exercise to keep the body fit and strong	2.94	4	3.07	3.15	3.16	3	2.92	10	2.86	2.90	2.99	4		
A09	B Sex and reproduction	2.66	19	2.59	2.63	2.65	24	2.99	7	2.82	2.95	2.95	5		
E08	H Cancer, what we know and how we can treat it	3.17	1	3.27	3.31	3.34	2	2.94	8	2.85	2.98	2.94	6		
A27	B Brutal, dangerous and threatening animals	2.72	16	2.75	2.73	2.62	26	3.02	6	2.96	3.02	2.90	7		
C08	S The possibility of life outside earth	2.55	36	2.70	2.75	2.60	30	2.92	13	2.94	3.05	2.87	8		
A25	E Tornados, hurricanes and cyclones	2.49	38	2.69	2.69	2.65	23	2.92	12	2.84	2.90	2.86	9		
A32	B Biological and chemical weapons	2.58	32	2.47	2.46	2.31	56	3.15	4	3.02	3.04	2.86	10		
C15	H Thought transference, mind-reading,	2.62	26	2.80	2.93	3.10	5	2.59	41	2.52	2.56	2.78	13		
A33	H The effect of electric shocks and lightning on the body	2.64	21	2.64	2.68	2.64	25	3.16	3	3.05	2.98	2.75	14		
E09	H Sexually transmitted diseases and how to be protected	2.88	5	2.80	2.91	3.07	6	2.70	27	2.62	2.80	2.74	15		
E12	H How alcohol and tobacco might affect the body	2.88	6	2.97	3.07	3.10	4	2.75	22	2.65	2.81	2.73	16		
A30	T How the atom bomb functions	2.31	57	2.24	2.17	2.08	72	3.09	5	2.98	2.98	2.73	17		
C14	H Ghosts and witches, and whether they may exist	2.69	18	2.83	2.94	3.04	8	2.45	56	2.33	2.50	2.71	21		
A12	B Cloning of animals	2.61	27	2.62	2.62	2.59	31	2.94	9	2.70	2.74	2.69	22		
E10	H How to perform first-aid and use basic medical equipment	2.96	3	3.09	3.17	3.01	9	2.78	20	2.71	2.91	2.67	23		
A29	H Deadly poisons and what they do to the human body	2.83	9	2.85	2.75	2.74	18	2.85	16	2.80	2.92	2.66	27		
A37	H What to eat to keep healthy and fit	2.86	8	2.96	3.08	3.05	7	2.60	39	2.60	2.69	2.63	30		
E11	H What we know about HIV/AIDS and how to control it	2.83	10	2.87	2.97	2.95	12	2.53	44	2.54	2.67	2.62	31		
Overall Mean ACE score		2.33		2.40	2.42	2.32		2.45		2.40	2.46	2.38			

Figure 12.2.1: Mean ACE scores for pupils depending on gender and on finding science difficult.

- Girls are generally interested in topics which are related to human aspects regardless of whether they find science easy or difficult.
- Boys' interests are more varied covering biology, physical sciences, space, human aspects and an earth science or technology topic. Again topics of interest are common to all groups and do not greatly depend on the perceived level of difficulty of science.
- Girls who find science most difficult show more interest in the supernatural while those who find science easy are more concerned with medical matters.
- Those, boys and girls, who do not rate science as difficult are the group who show more interest in atoms and molecules, not listing this in their least favourite ten. They also rate chemicals and their properties more highly.
- The most significant result from this analysis is that level of interest in science topics does not depend on the ease or difficulty of the subject to the pupil and that topics of interest are very similar for boys and girls regardless of whether they perceive science as difficult or easy for them.

We will now look at F02 *school science is interesting* and look at how interest in ACE correlates with the different responses to this topic. When looking at level of interest in ACE against an expressed interest/ lack of interest in science the obvious results are obtained as can be seen

from the mean ACE scores at the foot of Figure 12.2.2. ACE scores are higher for those who express an interest in science!

For those with no interest in science only 11 of the 108 questions show a Likert score of 2.50 (50% interest) or greater, whereas for those who show great interest over 75 of the topics score more than 2.50. The eleven topics of interest are the already listed top ten for the whole pupil population with the addition of *Sex and reproduction*, which does not appear in the overall list.

		Number in group		177		319		156		367	
		Girl				Boy					
F02 School science is interesting (1 not, 4 very)		1	rank	4	rank	1	rank	4	rank		
A31	P Explosive chemicals	2.38	19	3.07	16	3.06	1	3.58	1		
A09	B Sex and reproduction	2.56	10	2.68	54	2.88	2	2.95	28		
A34	S How it feels to be weightless in space	2.64	6	3.13	12	2.85	3	3.35	2		
C13	H Why we dream and what dreams mean	3.07	1	3.39	3	2.82	4	3.05	18		
A40	H How to exercise to keep the body fit and strong	2.89	3	3.17	8	2.81	5	3.01	21		
A33	H The effect of electric shocks and lightning on the body	2.34	21	2.95	23	2.71	6	3.23	5		
A27	B Brutal, dangerous and threatening animals	2.40	17	2.93	29	2.71	7	3.19	8		
A47	T How petrol and diesel engines work	1.55	87	2.03	105	2.70	8	2.73	53		
A32	B Biological and chemical weapons and what they do to the body	2.01	44	2.94	25	2.69	9	3.34	3		
E08	H Cancer and how we can treat it	2.90	2	3.47	2	2.64	10	3.19	7		
E09	H Sexually transmitted diseases and how to be protected	2.63	7	3.05	17	2.55	13	2.88	35		
A30	T How the atom bomb functions	1.86	63	2.59	60	2.55	14	3.32	4		
A29	H Deadly poisons and what they do to the human body	2.38	18	3.18	7	2.54	15	3.08	15		
E12	H How alcohol and tobacco might affect the body	2.61	8	3.25	4	2.44	18	2.92	31		
C08	S The possibility of life outside earth	1.95	47	3.01	18	2.42	19	3.21	6		
A23	E How meteors or asteroids may cause disasters on earth	1.93	50	2.74	43	2.41	20	3.15	10		
A37	H What to eat to keep healthy and fit	2.81	4	3.10	14	2.39	22	2.75	51		
E10	H How to perform first-aid	2.58	9	3.47	1	2.33	28	3.10	14		
E11	H What we know about HIV/AIDS and how to control it	2.55	11	3.21	5	2.19	39	2.81	45		
A07	B How the human body is built and functions	2.29	24	3.20	6	2.17	42	2.72	56		
E16	B How to protect endangered species of animals	2.27	25	3.14	10	2.04	51	2.84	39		
E32	B How gene technology can prevent diseases	1.94	49	3.15	9	1.96	59	2.87	36		
A41	H Plastic surgery and cosmetic surgery	2.72	5	2.73	45	1.95	60	2.05	100		
E42	N Phenomena that scientists still cannot explain	1.67	75	2.95	24	1.85	74	3.18	9		
Mean ACE score for group		1.95		2.65		2.07		2.67			

Figure 12.2.2 Likert scores for those who find science interesting split by gender.

From Figure 12.2.2 we can see that:

- Mean ACE Likert scores increase with interest in science for both boys and girls.
- Girls in Groups 1 and 4 have five of the same topics in their top ten and both groups have at least 7 human interest topics on their list.
- Group 1 Girls rate *plastic surgery* (this is at 100 on the Group 4 boys list!) and *sex and reproduction* higher than their counterparts although overall Likert scores are similar. Group 4 Girls are more interested in how the human body functions, gene technology and how to protect endangered species of animals.
- The two boy groups share a common interest in the violent and destructive as well as *how it feels to be weightless in space*; otherwise their main interests are different. Group 4 boys are drawn to even more violent occurrences and also to space and a nature of science topic. Group 1 boys share five of the Group 1 girl interests expressing

interest in dreams, sex and reproduction and how to exercise to keep fit. Group 4 boys only share one topic with Group 4 girls and that is *cancer and how to treat it*.

As large differences in Likert scores were observed between the different groups a table showing topics where the differences were greatest for the two extreme groups (1 and 4) was produced which is shown in Figure 12.2.3 below.

		Likert scores for groups who find school science interesting (1-not/ 4 very)	1	2	3	4	Diff 1-4
		Topic / Number in group	335	562	1141	689	
E42	N	Phenomena that scientists still cannot explain	1.75	2.23	2.66	3.07	-1.32
E40	N	Inventions and discoveries that have changed the world	1.64	2.14	2.53	2.88	-1.24
E41	N	Very recent inventions and discoveries in science and technology	1.65	2.03	2.46	2.85	-1.20
E32	B	How gene technology can prevent diseases	1.94	2.28	2.67	3.00	-1.06
E21	T	New sources of energy from the sun, wind, tides, waves, etc.	1.80	2.03	2.47	2.84	-1.03
A17	P	Atoms and molecules	1.55	1.66	2.12	2.56	-1.02
E38	N	Big blunders and mistakes in research and inventions	1.70	2.07	2.31	2.70	-1.00
A46	T	How X-rays, ultrasound, etc. are used in medicine	1.92	2.20	2.52	2.91	-0.99
E34	N	Why religion and science sometimes are in conflict	1.48	1.86	2.19	2.46	-0.98
E39	N	How scientific ideas sometimes challenge religion and authority	1.49	1.82	2.10	2.46	-0.98
E18	B	Medicinal use of plants	1.76	2.00	2.37	2.73	-0.97
E36	N	Why scientists sometimes disagree	1.51	1.80	2.08	2.45	-0.95
E20	T	How energy can be saved or used in a more effective way	1.77	2.03	2.41	2.71	-0.95
C08	S	The possibility of life outside earth	2.17	2.58	2.90	3.11	-0.94
E07	H	How to control epidemics and diseases	2.03	2.39	2.70	2.96	-0.93
		Mean ACE score	2.01	2.21	2.44	2.66	-0.66

Figure 12.2.3 Difference of interest in ACE for those who find science interesting (4) and those who do not (1)

Looking at topics where the difference in Likert scores is greatest between those who find science very interesting and those who do not find it at all interesting highlights areas where preferences vary.

- Seven of the eight Nature of science questions feature in this list and all are of at least moderate interest to the keen group (Likert scores from 2.45 - 3.07) while scores for the not keen group are all below 1.75.
- Technology items also feature in this list with four topics on X-rays, new sources of energy and ways of saving energy as well as how a nuclear power plant works. Again it is the keen group who show interest.
- Medicinal aspects are also of interest to group 4 pupils as shown by responses to E32, E07 and E18.

To investigate if those who visit science centres show a more positive approach to science topics the F02 file was further split using the responses to H09, *visits to science centres*. The mean Likert scores for sections A, C and E for the different categories are tabulated in Figure 12.2.4 showing the increase in score both with liking science (F02) and visiting science centres.

F02/H09	1	2	3	4
1	1.81	2.07	2.16	2.20
2	2.07	2.15	2.32	2.40
3	2.24	2.39	2.50	2.58
4	2.47	2.61	2.68	2.79

Figure 12.2.4: Mean ACE scores for pupils in the different interest and visit categories

The difference in Mean ACE between those who are really not interested in science and those who are very interested is approximately 0.5 and the increase in interest between those who never visit and those who visit science centres often in a category is between 0.3 and 0.4. It appears that visiting a science centre may increase interest in spite of a pupils stated indifference to science topics at school although this conclusion should be treated with caution as it is not known whether the increase in interest is a direct result of visits to science centres or other factors. The mean Likert score difference between the two extreme groups is almost 1.0 but for different topics there are much wider variations. There is only one topic where the value is higher for the low interest group and this is *Sex and reproduction* where the values are very similar to one another.

Topic	F02/H09 Groups (1.1 never visited/ not interested in science, 4.4 visit science centres often and interested in science at school)		1.1		4.4		Difference 1.1-4.4
	Number in Group		122		168		
			rank	rank			
E42	N	Phenomena that scientists still cannot explain	1.49	89	3.26	7	-1.77
E40	N	Inventions and discoveries that have changed the world	1.46	94	3.05	24	-1.59
E41	N	Very recent inventions and discoveries in S&T	1.47	91	3.04	27	-1.57
E21	T	New sources of energy from the sun, wind, tides, waves, etc.	1.58	76	3.07	20	-1.49
E34	N	Why religion and science sometimes are in conflict	1.29	107	2.77	60	-1.48
E32	B	How gene technology can prevent diseases	1.69	64	3.10	16	-1.41
A46	T	How X-rays, ultrasound, etc. are used in medicine	1.67	66	3.06	22	-1.39
E20	T	How energy can be saved or used in a more effective way	1.50	85	2.89	46	-1.39
A44	S	Rockets, satellites and space travel	1.61	73	3.00	32	-1.39
E07	H	How to control epidemics and diseases	1.71	63	3.07	19	-1.36
E39	N	How scientific ideas sometimes challenge religion and authority	1.34	104	2.68	71	-1.35
C08	S	The possibility of life outside earth	1.99	33	3.31	5	-1.32
E36	N	Why scientists sometimes disagree	1.36	102	2.67	73	-1.31
E38	N	Big blunders and mistakes in research and inventions	1.55	80	2.86	50	-1.31
A45	T	The use of satellites for communication and other purposes	1.43	97	2.74	62	-1.31

Figure 12.2.5: Topics where Likert score varied most between extreme groups

In Table 12.2.5 above the topics have been sorted in order of decreasing difference in Likert scores for the two extreme groups. Splitting results in this way will, as may be expected, give widely differing Likert scores and there are several cases where the difference is over 1.5 which corresponds to a difference in agreement of approximately 70%.

Looking at topics of greatest difference in interest again highlights:

- Nature of science topics and the three technology topics of renewable forms of energy, saving energy and x-rays in medicine engage those who are keen on science and who visit science centres.
- Those who are disinterested in science and do not visit science centres are keener on human aspect topics particularly concerning fitness, sexual health and reproduction.
- The keenest group are even more interested in violent events such as electric shocks and biological weapons.

One of the most noticeable features of Table 12.2.6 where the top ten topics for each of the two extreme groups are listed is the low level of interest in ACE topics of the least interested group where only *three* of the 108 items in ACE score above 50% interest at 2.50.

While these groups only share 5 of the others top ten most of the topics appear in the top ten for the whole S3 cohort surveyed.

- Group 1.1 (Not interested in science and never visit science centres) pupils have a stronger interest in sexual matters than other groups identified (A09 and E09) and Group 4.4 pupils show a strong interest in *Phenomena that scientists cannot explain*.

		F02/H09	Group		1.1	4.4
			Number in Group		122	168
					rank	rank
E10	H	How to perform first-aid and use basic medical equipment	2.21	11	3.43	1
A31	P	Explosive chemicals	2.36	7	3.39	2
E08	H	Cancer, what we know and how we can treat it	2.39	5	3.38	3
A34	S	How it feels to be weightless in space	2.42	4	3.35	4
C08	S	The possibility of life outside earth	1.99	33	3.31	5
A32	B	Biological and chemical weapons and what they do to the body	1.98	34	3.28	6
E42	N	Phenomena that scientists still cannot explain	1.49	89	3.26	7
C13	H	Why we dream while we are sleeping, and what dreams mean	2.60	3	3.23	8
A33	H	The effect of electric shocks and lightning on the body	2.15	18	3.23	9
E12	H	How alcohol and tobacco might affect the body	2.34	8	3.21	10
A27	B	Brutal, dangerous and threatening animals	2.28	10	3.12	14
E09	H	Sexually transmitted diseases and how to be protected	2.38	6	3.05	23
A40	H	How to exercise to keep the body fit and strong	2.66	2	3.01	30
A37	H	What to eat to keep healthy and fit	2.31	9	2.84	51
A09	B	Sex and reproduction	2.80	1	2.79	56

Figure 12.2.6: Top ten for the two extreme groups 1.1 and 4.4

Further splitting of the spreadsheet into gender differences is shown in Table 12.2.7 and this shows up some rather interesting features.

As will be seen from Table 12.2.7 the groups only share one topic in common and that is *How it feels to be weightless in space*. The most interested group of boys only share one other topic with the other boys and that is *explosive chemicals*.

- Space topics motivate the keen boys, as do items of a violent or destructive nature.
- Boys not keen on science have more in common with their girl compatriots but also are much keener on technological items. *How petrol and diesel engines work* has the distinction of being second top of their list while being at 106 for the other girl group.
- Health and human issues predominate in both girls' lists with the Group 4 girls being more concerned with diseases and how to control them and the other group being more interested in appearances and the use of cosmetic surgery.
- Group 4 girls were the only ones here to show an interest in animals, which was a prime concern of primary school girls.

We have looked at those who like science at school but there is another topic similar to this in the ROSE questionnaire, this is F05 *I like science better than most other subjects*. We looked at this to see if any new facts came to light.

Most of the top interest topics for groups 1 and 4 are very similar to the overall top ten.

- Items, which interest only those who like science, better than most subjects are probably quite significant. These are a nature of science topic *Big blunders and mistakes in research and inventions*, *How computers work* and *Chemicals and how they react*.
- Those who do not like science better than most subjects have lower Likert scores than the other group and show more comparative interest in keeping healthy, animals and mobile phones.

When topics where interest level is greatest are examined:

- it is again found that nature of science topics feature for both boys and girls.
- Keen science boys and girls are much more interested in two physical science questions, namely *atoms and molecules* and *chemical reactions*.
- It is probably worth noting the small numbers of pupils who like science better than most subjects (12.5%)

		F02/H09/gender	Number in Group		62		59		85		82	
			Group		1.1girl	rank	1.1boy	rank	4.4 girl	rank	4.4 boy	rank
A09	B	Sex and reproduction	2.79	1	2.85	1	2.66	79	2.90	42		
A47	T	How petrol and diesel engines work	1.38	77	2.75	2	2.15	106	2.67	64		
A40	H	How to exercise to keep the body fit and strong	2.68	2	2.64	3	3.22	13	2.78	55		
A31	P	Explosive chemicals	2.11	17	2.64	4	3.16	18	3.62	1		
A34	S	How it feels to be weightless in space	2.26	10	2.62	5	3.25	10	3.45	3		
A27	B	Brutal, dangerous and threatening animals	2.00	25	2.59	6	3.08	28	3.15	18		
C13	H	Why we dream while we are sleeping, and what dreams mean	2.63	3	2.58	7	3.34	6	3.11	22		
E08	H	Cancer, what we know and how we can treat it	2.37	7	2.44	8	3.60	2	3.16	17		
E28	T	How to use and repair everyday equipment	1.28	94	2.41	9	2.32	98	3.00	31		
C06	T	How mobile phones can send and receive messages	2.03	22	2.39	10	2.87	51	2.94	39		
E12	H	How alcohol and tobacco might affect the body	2.32	8	2.37	13	3.35	5	3.06	26		
A33	H	The effect of electric shocks and lightning on the body	1.97	28	2.35	14	3.06	30	3.40	4		
E09	H	Sexually transmitted diseases and how to be protected	2.44	6	2.34	15	3.18	16	2.91	41		
C08	S	The possibility of life outside earth	1.69	45	2.32	18	3.23	12	3.38	5		
C03	T	The use of lasers for technical purposes (CD Players etc)	1.61	57	2.30	19	2.54	86	3.22	13		
A32	B	Biological and chemical weapons and what they do to the body	1.71	42	2.29	20	3.09	26	3.46	2		
A30	T	How the atom bomb functions	1.63	54	2.28	23	2.72	68	3.35	8		
A29	H	Deadly poisons and what they do to the human body	1.92	31	2.21	27	3.28	9	3.09	25		
E10	H	How to perform first-aid and use basic medical equipment	2.26	9	2.19	29	3.64	1	3.22	14		
E11	H	What we know about HIV/AIDS and how to control it	2.20	14	2.19	31	3.40	4	2.87	49		
A07	B	How the human body is built and functions	2.06	20	2.10	33	3.33	7	2.67	65		
A23	E	How meteors or asteroids may cause disasters on earth	1.60	59	2.09	34	2.81	58	3.35	7		
A37	H	What to eat to keep healthy and fit	2.53	4	2.07	36	3.12	22	2.53	79		
A22	S	Black holes, supernovas and other objects in space	1.60	58	2.02	40	2.69	73	3.29	9		
A44	S	Rockets, satellites and space travel	1.26	97	2.00	42	2.71	70	3.28	10		
E16	B	How to protect endangered species of animals	1.98	27	1.90	51	3.41	3	2.93	40		
E32	B	How gene technology can prevent diseases	1.55	65	1.85	55	3.31	8	2.86	51		
A41	H	Plastic surgery and cosmetic surgery	2.47	5	1.79	67	2.88	49	2.19	99		
E42	N	Phenomena that scientists still cannot explain	1.30	89	1.69	79	3.16	19	3.35	6		

Figure 12.2.7: Mean ACE scores for the groups split by gender

Next we looked at F14 *I want to be a scientist*.

As will be seen from Figure 12.2.8 interest in ACE increases with the desire to be a scientist although it is perhaps surprising how low the girls score is for those who most want to be scientists. It perhaps shows that they have a rather narrower range of interests than the boys. More boys than girls aspire to be scientists but in total only about 8% of our sample wanted to follow this route to a career.

As would be expected those who want to be scientists show (in Figure 12.2.8) higher scores for the two questions on school science (F02 and F05).

When *differences* in interest level are looked at eight of the top twelve are the same for both groups and involve many of the nature of science topics. Medical topics also crop up such as gene technology, the medicinal use of plants and control of disease. As expected atoms and molecules also appear on the list.

		Girl					Boy				
I want/do not want to be a scientist		1	2	3	4	Differ	1	2	3	4	Differ
Number in group		879	272	188	89	1-4	578	330	224	127	1-4
F02	I like school science	2.52	2.95	3.22	3.36		2.54	3.01	3.19	3.40	-0.85
F05	Find it more interesting than other subjects	1.73	2.39	2.67	2.98		1.84	2.40	2.75	3.10	-1.26
E42	N Phenomena that scientists still cannot explain *	2.26	2.62	2.86	3.09	-0.83	2.36	2.76	3.08	3.31	-0.95
A17	P Atoms and molecules *	1.70	2.21	2.40	2.51	-0.80	1.96	2.29	2.44	2.80	-0.84
E18	B Medicinal use of plants *	2.16	2.51	2.80	2.94	-0.79	1.97	2.38	2.57	2.73	-0.76
E36	N Why scientists sometimes disagree *	1.80	2.11	2.34	2.58	-0.78	1.88	2.18	2.32	2.70	-0.82
E37	N Famous scientists and their lives	1.51	1.87	1.99	2.27	-0.76	1.69	1.97	2.21	2.42	-0.73
E34	N Why religion and science sometimes are in conflict *	1.87	2.26	2.48	2.58	-0.71	1.89	2.15	2.43	2.69	-0.80
E38	N Big blunders and mistakes in research and inventions *	1.90	2.21	2.61	2.61	-0.71	2.25	2.50	2.82	3.01	-0.76
A44	S Rockets, satellites and space travel *	1.80	2.21	2.37	2.47	-0.67	2.47	2.87	3.06	3.30	-0.83
A18	H How radioactivity affects the human body	2.16	2.40	2.70	2.82	-0.65	2.47	2.60	3.00	3.10	-0.63
A32	B Biological and chemical weapons and what they do to the body	2.29	2.64	2.88	2.92	-0.63	2.86	3.08	3.29	3.26	-0.40
E39	N How scientific ideas sometimes challenge religion and authority *	1.78	2.16	2.36	2.40	-0.63	1.85	2.26	2.47	2.79	-0.94
A46	T How X-rays, ultrasound, etc. are used in medicine	2.37	2.64	2.93	3.00	-0.63	2.24	2.42	2.65	2.86	-0.62
E42	N Phenomena that scientists still cannot explain *	2.26	2.62	2.86	3.09	-0.83	2.36	2.76	3.08	3.31	-0.95
E39	N How scientific ideas sometimes challenge religion and authority *	1.78	2.16	2.36	2.40	-0.63	1.85	2.26	2.47	2.79	-0.94
E32	B How gene technology can prevent diseases	2.49	2.75	3.12	3.06	-0.57	2.22	2.52	2.85	3.13	-0.91
A17	P Atoms and molecules *	1.70	2.21	2.40	2.51	-0.80	1.96	2.29	2.44	2.80	-0.84
A44	S Rockets, satellites and space travel *	1.80	2.21	2.37	2.47	-0.67	2.47	2.87	3.06	3.30	-0.83
E36	N Why scientists sometimes disagree *	1.80	2.11	2.34	2.58	-0.78	1.88	2.18	2.32	2.70	-0.82
C10	S Unsolved mysteries in outer space	2.26	2.57	2.79	2.78	-0.52	2.36	2.71	2.93	3.18	-0.82
E41	N Very recent inventions and discoveries in science and technology	1.98	2.37	2.69	2.57	-0.60	2.33	2.69	2.84	3.14	-0.81
E34	N Why religion and science sometimes are in conflict *	1.87	2.26	2.48	2.58	-0.71	1.89	2.15	2.43	2.69	-0.80
E03	H The ozone layer and how it may be affected by humans	2.04	2.31	2.55	2.64	-0.61	1.93	2.33	2.57	2.70	-0.77
E07	H How to control epidemics and diseases	2.58	2.83	3.18	3.10	-0.52	2.21	2.53	2.81	2.98	-0.77
E38	N Big blunders and mistakes in research and inventions *	1.90	2.21	2.61	2.61	-0.71	2.25	2.50	2.82	3.01	-0.76
E18	B Medicinal use of plants *	2.16	2.51	2.80	2.94	-0.79	1.97	2.38	2.57	2.73	-0.76
	Mean ACE	2.27	2.47	2.64	2.61		2.27	2.45	2.60	2.73	

Figure 12.2.8: Greatest differences in Mean ACE score by gender for pupils wanting/ not wanting to be scientists (* common to both groups)

When results are placed in order of preference for the different groups as shown in Figure 12.2.9 the following points can be observed as noted after the Figure.

		Gender					Boy				
F014 I want/do not want to be a scientist		1	2	3	4	Diff	1	2	3	4	Diff
Number in group		879	272	188	89		578	330	224	127	
F02	I like school science	2.52	2.95	3.22	3.36	-0.84	2.54	3.01	3.19	3.40	-0.85
F05	Find it more interesting than other subjects	1.73	2.39	2.67	2.98	-1.25	1.84	2.40	2.75	3.10	-1.26
C13	H Why we dream while we are sleeping, and what dreams mean	3.33	3.26	3.32	3.21	0.11	2.84	2.83	3.02	3.02	-0.17
E08	H Cancer, what we know and how we can treat it	3.22	3.22	3.45	3.45	-0.24	2.80	2.91	3.12	3.14	-0.33
A40	H How to exercise to keep the body fit and strong	3.06	3.04	3.18	2.97	0.09	2.90	2.98	2.87	2.85	0.05
E10	H How to perform first-aid and use basic medical equipment	2.99	3.04	3.34	3.24	-0.24	2.68	2.79	2.84	3.09	-0.40
A37	H What to eat to keep healthy and fit	2.96	2.98	3.11	2.89	0.07	2.63	2.64	2.65	2.54	0.09
A34	S How it feels to be weightless in space	2.94	3.09	3.13	3.19	-0.25	3.05	3.16	3.40	3.45	-0.39
E12	H How alcohol and tobacco might affect the body	2.93	3.02	3.15	3.04	-0.11	2.67	2.75	2.82	2.80	-0.14
E09	H Sexually transmitted diseases and how to be protected	2.86	2.88	2.97	2.95	-0.10	2.66	2.67	2.77	2.90	-0.25
C14	H Ghosts and witches, and whether they may exist	2.82	2.84	2.94	2.89	-0.07	2.42	2.43	2.53	2.52	-0.10
C11	H Life and death and the human soul	2.82	2.87	3.11	3.03	-0.22	2.45	2.58	2.87	2.87	-0.43
A41	H Plastic surgery and cosmetic surgery	2.81	2.71	2.78	2.66	0.15	1.93	2.02	2.16	2.08	-0.15
E11	H What we know about HIV/AIDS and how to control it	2.81	2.91	3.22	2.98	-0.17	2.44	2.63	2.70	2.90	-0.45
C15	H Thought transference, mind-reading, sixth sense, intuition, etc.	2.79	2.83	2.94	2.90	-0.11	2.50	2.47	2.76	2.87	-0.37
A39	H The ability of lotions and creams to keep the skin young	2.74	2.72	2.79	2.54	0.20	1.88	1.79	1.85	1.97	-0.09
A38	H Eating disorders like anorexia or bulimia	2.73	2.74	2.93	2.69	0.04	1.97	1.98	2.12	2.17	-0.20
E08	H Cancer, what we know and how we can treat it	3.22	3.22	3.45	3.45	-0.24	2.80	2.91	3.12	3.14	-0.33
E10	H How to perform first-aid and use basic medical equipment	2.99	3.04	3.34	3.24	-0.24	2.68	2.79	2.84	3.09	-0.40
A29	H Deadly poisons and what they do to the human body	2.69	2.83	3.13	3.21	-0.52	2.65	2.87	3.05	3.10	-0.45
C13	H Why we dream while we are sleeping, and what dreams mean	3.33	3.26	3.32	3.21	0.11	2.84	2.83	3.02	3.02	-0.17
A34	S How it feels to be weightless in space	2.94	3.09	3.13	3.19	-0.25	3.05	3.16	3.40	3.45	-0.39
A31	P Explosive chemicals	2.56	2.86	3.01	3.17	-0.61	3.18	3.38	3.45	3.50	-0.32
E07	H How to control epidemics and diseases	2.58	2.83	3.18	3.10	-0.52	2.21	2.53	2.81	2.98	-0.77
E42	N Phenomena that scientists still cannot explain	2.26	2.62	2.86	3.09	-0.83	2.36	2.76	3.08	3.31	-0.95
E32	B How gene technology can prevent diseases	2.49	2.75	3.12	3.06	-0.57	2.22	2.52	2.85	3.13	-0.91
E12	H How alcohol and tobacco might affect the body	2.93	3.02	3.15	3.04	-0.11	2.67	2.75	2.82	2.80	-0.14
C11	H Life and death and the human soul	2.82	2.87	3.11	3.03	-0.22	2.45	2.58	2.87	2.87	-0.43
A27	B Brutal, dangerous and threatening animals	2.61	2.80	3.01	3.02	-0.42	2.90	3.02	3.12	3.06	-0.15
A31	P Explosive chemicals	2.56	2.86	3.01	3.17	-0.61	3.18	3.38	3.45	3.50	-0.32
A34	S How it feels to be weightless in space	2.94	3.09	3.13	3.19	-0.25	3.05	3.16	3.40	3.45	-0.39
A27	B Brutal, dangerous and threatening animals	2.61	2.80	3.01	3.02	-0.42	2.90	3.02	3.12	3.06	-0.15
A40	H How to exercise to keep the body fit and strong	3.06	3.04	3.18	2.97	0.09	2.90	2.98	2.87	2.85	0.05
A33	H The effect of electric shocks and lightning on the body	2.55	2.67	2.93	2.98	-0.43	2.88	3.06	3.20	3.28	-0.40
A32	B Biological and chemical weapons and what they do to the body	2.29	2.64	2.88	2.92	-0.63	2.86	3.08	3.29	3.26	-0.40
A09	B Sex and reproduction	2.58	2.71	2.72	2.64	-0.06	2.85	2.94	3.04	2.97	-0.12
C13	H Why we dream while we are sleeping, and what dreams mean	3.33	3.26	3.32	3.21	0.11	2.84	2.83	3.02	3.02	-0.17
E08	H Cancer, what we know and how we can treat it	3.22	3.22	3.45	3.45	-0.24	2.80	2.91	3.12	3.14	-0.33
A25	E Tornados, hurricanes and cyclones	2.55	2.69	2.83	2.89	-0.34	2.80	2.85	2.99	3.13	-0.33
C07	T How computers work	2.26	2.44	2.51	2.49	-0.22	2.76	3.04	2.99	3.13	-0.37
A30	T How the atom bomb functions	2.06	2.39	2.51	2.64	-0.58	2.76	3.04	3.24	3.31	-0.55
C08	S The possibility of life outside earth	2.53	2.75	3.05	2.97	-0.44	2.72	3.03	3.23	3.38	-0.66
A23	E How meteors or asteroids may cause disasters on earth	2.32	2.53	2.77	2.74	-0.42	2.70	2.88	3.10	3.17	-0.47
A31	P Explosive chemicals	2.56	2.86	3.01	3.17	-0.61	3.18	3.38	3.45	3.50	-0.32
A34	S How it feels to be weightless in space	2.94	3.09	3.13	3.19	-0.25	3.05	3.16	3.40	3.45	-0.39
C08	S The possibility of life outside earth	2.53	2.75	3.05	2.97	-0.44	2.72	3.03	3.23	3.38	-0.66
A22	S Black holes, supernovas and other objects in space	2.20	2.42	2.58	2.79	-0.59	2.59	2.86	3.13	3.33	-0.74
A30	T How the atom bomb functions	2.06	2.39	2.51	2.64	-0.58	2.76	3.04	3.24	3.31	-0.55
E42	N Phenomena that scientists still cannot explain	2.26	2.62	2.86	3.09	-0.83	2.36	2.76	3.08	3.31	-0.95
A44	S Rockets, satellites and space travel	1.80	2.21	2.37	2.47	-0.67	2.47	2.87	3.06	3.30	-0.83
A33	H The effect of electric shocks and lightning on the body	2.55	2.67	2.93	2.98	-0.43	2.88	3.06	3.20	3.28	-0.40
A32	B Biological and chemical weapons and what they do to the body	2.29	2.64	2.88	2.92	-0.63	2.86	3.08	3.29	3.26	-0.40
C10	S Unsolved mysteries in outer space	2.26	2.57	2.79	2.78	-0.52	2.36	2.71	2.93	3.18	-0.82
A23	E How meteors or asteroids may cause disasters on earth	2.32	2.53	2.77	2.74	-0.42	2.70	2.88	3.10	3.17	-0.47
E08	H Cancer, what we know and how we can treat it	3.22	3.22	3.45	3.45	-0.24	2.80	2.91	3.12	3.14	-0.33
E41	N Very recent inventions and discoveries in science and technology	1.98	2.37	2.69	2.57	-0.60	2.33	2.69	2.84	3.14	-0.81

Figure 12.2.9: Mean ACE scores for those who want/ do not want to be scientists by gender

Girls who do not want to be scientists: Apart from how it feels to be weightless in space all the top topics are related to human aspects, although these topics cover quite a wide selection of items.

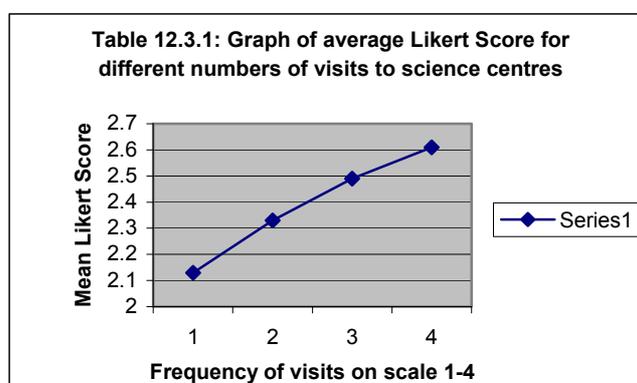
Girls who want to be scientists share six of their list with the other girls and seem more interested in topics involving violence such as brutal animals and deadly poisons. They also show an interest in medical matters such as gene therapy and how to control epidemics.

Boys who want to be scientists are much more interested in space (5 items) as well as destructive events such as explosive chemicals, how an atom bomb works, the effect of electrical shocks and biological and chemical weapons on the body.

Boys who do not want to be scientists are still interested in violent and brutal events but also in more human aspects such as how to keep healthy and also the meaning of dreams.

12.3 Interest in ACE topics depending on the number of visits to a science centre

As can be seen from the table interest in ACE topics increases with the number of visits to the science centre. Whether the visits increase interest or whether those who are interested go more often cannot be said. The difference in interest is appreciable at 0.47 between those who visit often (4) and those who have never visited (1).



If we compare the two extreme groups 1 and 4 looking for similarities and differences what will we find? When looking at the most popular and least popular topics overall no major differences arise between the two groups and they have a similar 'top ten' to that of the whole school sample.

If we look for differences in the different domains again we do not find much in the way of different interest but a difference in the level of interest. In the space domain those who have never been to a science centre only score *experiencing weightlessness* above 2.50, whereas those who visit frequently rate five topics above 2.50. In the technology domain, group 1 give their highest score of 2.39 to mobile phones whereas group 4 pupils show a wider interest.

From Figure 10.3.2 it can be seen that for those who have never visited a science centre the level of interest in science topics, as might be expected, is highest for the three science group, next highest for two science groups, with the single science groups scoring lowest. Of these groups SG Science appear least interested. Interest increases in all groups with the number of visits to a science centre. The increase is least for the three science group, from 2.59 to 2.78. For the single discrete science and two science groups the increase is by a fairly significant 0.4. The biggest increase of all is with the SG Science classes where there is an increase of 0.70 (a swing from less than 30% interested to over 60% interested). It must be reiterated that the cause of this increase cannot be positively identified as being due to the number of visits to the science centre.

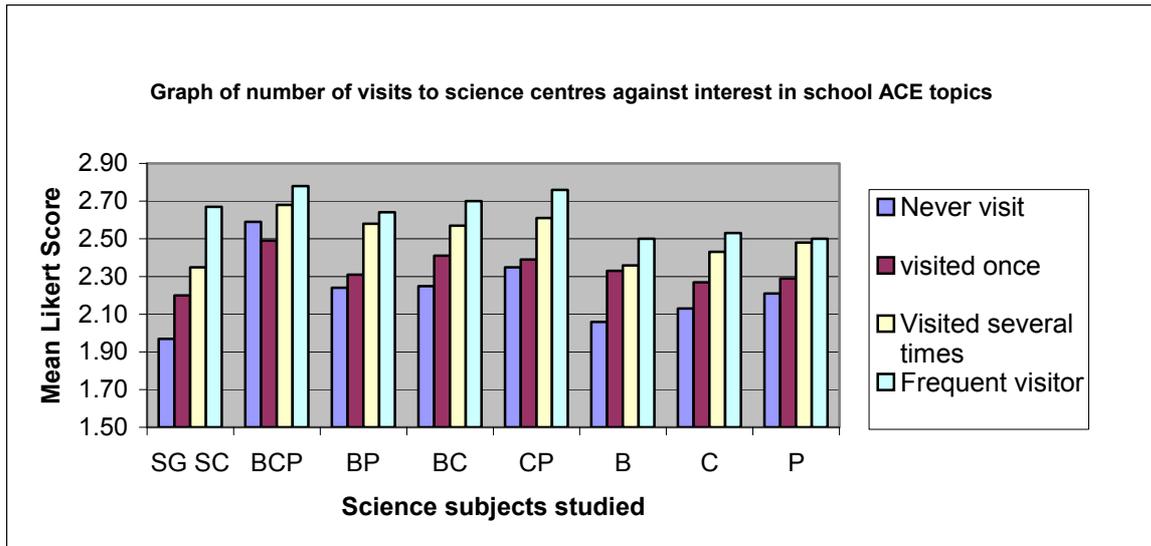


Figure 12.3.2: Interest according to subjects studied
(SC = Science, B= Biology, C= Chemistry and P= Physics)

The Standard Grade Science Group

The differences in the SG Science pupils' interests, between those who have not visited a science centre (Group 1) and those who are frequent visitors are marked as can be seen from Figure 12.3.3. Each has only 5 items in the others top ten. Those who do not visit science centres are more interested in human and health issues while those who visit science centres frequently are much more interested in technology with three from that domain in their top 10.

		Top Ten (1 never visit, 4 - visit often)	1	4		
	Topic	No in group	84	41		
A40	H	How to exercise to keep the body fit and strong	2.93	1	3.02	16
E08	H	Cancer, what we know and how we can treat it	2.68	2	3.29	4
A37	H	What to eat to keep healthy and fit	2.68	3	3.03	12
A09	B	Sex and reproduction	2.65	4	2.76	42
E09	H	Sexually transmitted diseases and how to be protected	2.63	5	3.15	6
E12	H	How alcohol and tobacco might affect the body	2.55	6	3.07	10
C13	H	Why we dream while we are sleeping, and what dreams mean	2.53	7	3.29	3
E11	H	What we know about HIV/AIDS and how to control it	2.38	8	3.02	13
A31	P	Explosive chemicals	2.36	9	3.15	7
A34	S	How it feels to be weightless in space	2.36	10	2.85	32
E10	H	How to perform first-aid and use basic medical equipment	2.35	12	3.07	9
C04	T	How cassette tapes, CDs and DVDs store and play sound and music	2.24	26	3.32	2
C07	T	How computers work	2.20	29	3.39	1
E16	B	How to protect endangered species of animals	2.14	34	3.18	5
C03	T	The use of lasers for technical purposes (CD Players etc)	1.93	64	3.10	8

Figure 12.3.3: Top ten topics for SG Science pupils who visit science centres

Generally they also show more interest in other technology questions as is shown in the table below, which gives the difference between Likert scores for Group 4 and the average Likert score for all SG Science pupils. Seven of the items are in the technology domain and it could be argued that E06 should also be in this category. This is the only group, so far identified, which

shows a special interest in technology subjects and this is something that should be investigated further.

Top 10: Where the difference is greatest in Likert scores between the Group 4 and average score

		Group	4	SG science	
		Number in Group	41	302	
Question	Topic	Science	Average	4-Average	
C07	T	How computers work	3.39	2.48	0.91
C04	T	How CDs and DVDs store and play sound and music	3.32	2.42	0.90
C03	T	The use of lasers for technical purposes	3.10	2.25	0.85
E21	T	Energy from the sun, wind, tides, waves, etc.	2.93	2.13	0.79
A44	S	Rockets, satellites and space travel	2.83	2.11	0.72
A45	T	The use of satellites for communication	2.54	1.84	0.70
E16	B	How to protect endangered species of animals	3.18	2.48	0.69
C05	T	How things like radios and televisions work	2.93	2.24	0.69
E06	H	How technology helps us to handle waste and sewage	2.71	2.02	0.69
C02	T	Optical instruments and how they work	2.61	1.94	0.67

Figure 12.3.4: Difference in Likert scores for those who visit science centres often and the average score.

Figure 12.3.4 shows where the interests of the SG science group who visit science centres often differ most markedly from the average. The greater interest in technology topics is very marked and 7 appear on the list. It could also be argued that E06 should also be in the technology category.

How much of this interest in technology has been generated by the science centres is not known.

		Those taking SG science who visit science centres often	Girl		Boy	
		Number in group	21		19	
C04	T	How cassette tapes, CDs and DVDs store and play sound and music	3.00	19	3.74	1
C07	T	How computers work	3.14	11	3.68	2
A31	P	Explosive chemicals	2.86	29	3.53	3
C03	T	The use of lasers for technical purposes (CD Players etc)	2.71	42	3.53	4
A29	H	Deadly poisons and what they do to the human body	2.71	40	3.47	5
C08	S	The possibility of life outside earth	2.62	49	3.47	6
C05	T	How things like radios and televisions work	2.52	59	3.42	7
A23	E	How meteors or asteroids may cause disasters on earth	2.43	70	3.32	8
A09	B	Sex and reproduction	2.24	86	3.32	9
A25	E	Tornados, hurricanes and cyclones	2.48	65	3.28	10
C13	H	Why we dream while we are sleeping, and what dreams mean	3.48	3	3.16	19
E09	H	Sexually transmitted diseases and how to be protected	3.24	6	3.11	26
E08	H	Cancer, what we know and how we can treat it	3.57	1	3.00	37
E10	H	How to perform first-aid and use basic medical equipment	3.19	7	2.89	48
E11	H	What we know about HIV/AIDS and how to control it	3.19	8	2.84	52
E16	B	How to protect endangered species of animals	3.52	2	2.79	54
A40	H	How to exercise to keep the body fit and strong	3.24	5	2.79	55
E21	T	New sources of energy from the sun, wind, tides, waves, etc.	3.15	9	2.63	73
A37	H	What to eat to keep healthy and fit	3.33	4	2.61	75
E23	B	How my body grows and matures	3.14	10	2.58	78

Figure 12.3.5: Top ten topics by gender for SG Science pupils who visit science centres often

On a further analysis of results it was found that only those who visited science centres frequently had this higher interest in technology as this was not shared by those who had

entered a 2 or 3 for this topic. Although two technology topics are top of the boys list values are high for girls also and they show a higher interest in new sources of energy than the boys.

The Three Science Group

Do other groups display such different patterns of interest?

Let us look at a group that has shown different patterns in our first report - the three science group. Being able to take three sciences in a Scottish school is not something that is available to the majority of pupils due to timetabling restrictions, but our sample had had 200 pupils who fell into this category.

		Three science groups (1 -never visit, 4- visit often)	1	4		
		Topic	Number in group	36		
A29	H	Deadly poisons and what they do to the human body	2.93	23	3.64	1
E08	H	Cancer, what we know and how we can treat it	3.57	1	3.58	2
C08	S	The possibility of life outside earth	3.20	12	3.50	3
A31	P	Explosive chemicals	3.53	2	3.47	4
E32	B	How gene technology can prevent diseases	2.93	26	3.47	5
A12	B	Cloning of animals	3.20	10	3.44	6
A06	E	The origin and evolution of life on earth	3.13	15	3.44	7
E42	N	Phenomena that scientists still cannot explain	3.21	9	3.44	8
E07	H	How to control epidemics and diseases	3.14	14	3.42	9
A33	H	The effect of electric shocks and lightning on the body	3.13	18	3.39	10
A34	S	How it feels to be weightless in space	3.40	4	3.36	12
A30	T	How the atom bomb functions	3.40	3	3.22	16
A25	E	Tornados, hurricanes and cyclones	3.33	5	3.08	24
C13	H	Why we dream while we are sleeping, and what dreams mean	3.33	6	3.08	25
A40	H	How to exercise to keep the body fit and strong	3.27	7	3.00	33
A41	H	Plastic surgery and cosmetic surgery	3.27	8	2.58	71

Figure 12.3.6: Top ten for the Three science groups

The Three Science group do not share the interest in technology of the SG Science group.

The top ten for those who visit science centres often and for those who have never visited only share four topics in common. One of these is a nature of science question which does not usually appear in any top ten list.

Those who have never visited have quite a varied list of interests and have six of the overall top ten on their list. They have two rather odd items on their list showing an interest in atomic bombs and also in plastic surgery. This is a small group of only 15 and so is probably not representative of the whole.

The group who often visit science centres only have three topics in their top ten which appear in the overall top ten. Apart from this their interests are mainly in the human focus domain with an interest in cloning and gene technology as well as how to control diseases, although top of their list is the question on what deadly poisons can do to the human body! This group are probably more interested in medical matters than other groups, perhaps because they are interested in careers in medicine and so are taking the three sciences which are required for entry to medical school.

12.4 Interest in science with school qualifications

Mean ACE scores for different categories and qualifications									
	B	BC	BCP	BP	C	CP	P	S	
Number in Group	369	392	128	51	258	260	140	302	Standard Grade
Biological sciences	2.40	2.63	2.65	2.45	2.34	2.36	2.17	2.25	
Earth science	2.24	2.38	2.52	2.34	2.26	2.48	2.27	2.11	
Human focus	2.63	2.75	2.8	2.64	2.57	2.59	2.39	2.41	
Nature of science	2.03	2.26	2.52	2.19	2.23	2.54	2.32	2.15	
Physical sciences	2.13	2.36	2.44	2.26	2.33	2.50	2.24	2.19	
Space	2.38	2.58	2.82	2.82	2.48	2.90	2.73	2.22	
Technology	2.10	2.28	2.55	2.41	2.35	2.72	2.48	2.20	
Mean ACE	2.35	2.53	2.65	2.48	2.40	2.56	2.35	2.25	
Number in Group	15	43	76		6(?)	27	24		Intermediate 2
Biological sciences	2.35	2.36	2.67		2.40	2.40	2.40		
Earth science	2.37	2.29	2.51		2.14	2.45	2.54		
Human focus	2.55	2.52	2.75		2.40	2.54	2.66		
Nature of science	2.27	2.21	2.66		3.10	2.71	2.64		
Physical sciences	1.81	2.14	2.38		1.98	2.45	2.20		
Space	2.45	2.57	2.82		2.67	2.81	2.75		
Technology	1.87	2.10	2.53		2.23	2.57	2.61		
Mean ACE	2.28	2.34	2.64		2.38	2.53	2.54		
Number in Group	283	20			297	15	34		Intermediate 1
Biological sciences	2.29	2.40			2.24	2.19	2.24		
Earth science	2.12	2.33			2.18	2.16	2.25		
Human focus	2.43	2.66			2.37	2.46	2.36		
Nature of science	1.93	2.19			2.00	2.77	2.25		
Physical sciences	2.17	2.30			2.27	2.24	2.33		
Space	2.23	2.78			2.30	2.74	2.72		
Technology	2.18	2.26			2.38	2.56	2.50		
Mean ACE	2.25	2.45			2.26	2.42	2.36		

Figure 12.4.1: ACE scores for different school qualifications

Levels of interest in ACE topics are highest for those studying the three sciences both at SG and at Intermediate 2 stages. Lowest levels are found for SG Science pupils and then for those taking a single science. Generally those taking two sciences at any level have a higher interest than those taking just one subject. Intermediate 1 pupils taking just one science have a level of interest on par with SG Science pupils.

Domains

Are pupils who take biology as a school subject more interested in topics in the biological domain than others and similarly what about those taking chemistry and physics?

Pupils taking SG Biology are most interested in topics with a human focus but their next choice is indeed the biological sciences. Others taking SG Biology have high scores here as well and there is a general lack of interest in biological sciences amongst pupils not taking biology at SG. Pupils taking physics and physics/chemistry are most interested in space topics followed by technology whereas those taking physics/ biology like space topics followed by those with a human focus. Pupils taking chemistry rate human focus topics most highly followed by space

items. The three science group rate space most highly followed by human focus and then biological topics, covering all three preferences of the single sciences.

Only the chemistry/ physics group rate physical science topics with a score of 2.50. Earth science topics are rated most highly by the three science and chemistry/ physics groups as would be expected. The more academic topics in the nature of science domain are most attractive to the three science group and again the chemistry/ physics group.

The space domain is most attractive to those taking physics, either alone or with other subjects and is least popular with SG Science, biology and chemistry pupils.

Technology topics are more popular with chemistry/ physics pupils and those taking the three sciences than for other groups.

The general trend is that pupils taking biology favour topics with a human interest whilst those taking physics seem to prefer space related topics. Pupils taking chemistry seem to have interests midway between these two groups and are quite interested in human focus aspects and also in space topics.

Intermediate 2

The numbers taking some of the subject combinations are small and so it is difficult to draw reliable conclusions but overall the trends at Intermediate 2 are similar to those for Standard Grade.

Intermediate 1

Levels of interest are lower for all domains here, with those taking two sciences having slightly higher mean Likert scores for ACE.

Human focus topics are most popular with those taking biology followed by biological science.

For the biology/chemistry pupils space, followed by human focus topics are top of their list.

Chemistry pupils rate technology followed by human focus items while those taking physics find space followed by technology most popular. The chemistry/ physics group rate space and technology but at top of their list is nature of science at 2.77. This is the highest score for any group and is surprising as the overall Likert score for this group is not high. There are however only 15 pupils in this group and so the result may not be representative.

No group shows much interest in the earth science or physical science domains.

Intermediate 1 pupils are less interested in science topics in the survey than other pupils but those taking physics and chemistry seem to have an interest in topics in the technology domain.

Summary of main conclusions for Section 12

- Boys generally show more interest in technology topics than girls. However girls show an interest in the human and medical aspects of technology, giving Likert scores of more than 2.5 for the use of X-rays and ultrasound in medicine and for how mobile phones work.
- There is a general lack of interest shown in causes of environmental damage such as the greenhouse effect and the ozone layer although pupils who visit science centres often have higher Likert scores (1.7-2.4) than those who never visit.
- Neither interest in particular science topics nor in level of interest in science generally depends on the perceived level of difficulty of school science.
- Boys who express an interest in science show more interest in space topics than other boys, while those who profess not to like science show more interest in human aspects such as how to keep fit and healthy. Both groups are interested in violent and destructive events.
- Girls are generally more engaged with human aspects, with girls who are keen on science being particularly interested in medical aspects such as gene therapy and how to control

the spread of disease. Girls who do not like science are keener on health and fitness, sexual health and reproduction.

- When difference in interest levels are examined it is found that the 'keen' group is much more engaged by the more intellectually demanding nature of science topics in addition to some technology related items such as new sources of energy, energy saving and also ways of preventing disease.
- Those who visit science centres often show a higher level of interest in science related topics.

13. Sections B, D, F and G: Do perceptions change with visits to science centres?

So far in our survey we have concentrated our efforts on Sections A, C and E. Let us now take a brief look at some other sections of the questionnaire to see if other perceptions alter with visits to the science centres and other parameters.

13.1 Section B

Two groups we have looked at in some detail previously have been the SG Science and the three science groups, so we will again choose these groups when looking at the other sections.

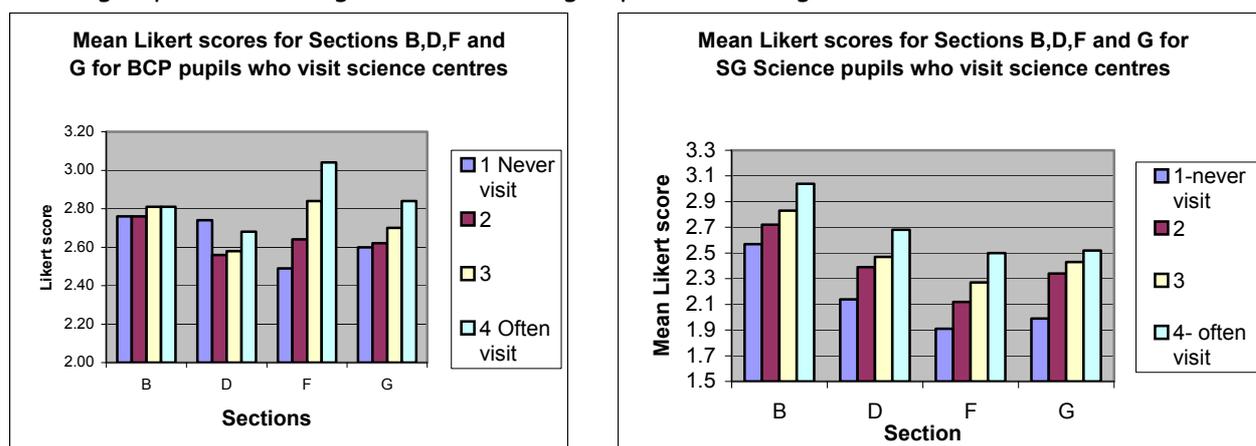


Figure 13.1.1: Mean Likert scores for Sections B, D, F and G for SG Science and the three science pupils

Figure 13.1.1 shows that mean Likert scores increase with visits to science centres for SG Science pupils for all sections but only increase for sections F and G for those taking the three sciences (the BCP group). We will look at the reasons for this below. While these observations below are noted we should perhaps emphasise that although perceptions differ with the number of visits to a science centre we cannot say that visiting the science centre **causes** the change in perception.

Nature of issue	Questions
Work nature and context	B3,B4,B5,B6,B7,B19
Creativity at work	B8,B10,B11
Personal satisfaction from the job	B9,B13,B15,B16,B25
Relationship with other people at work	B1,B2,B14,B21,B24,B26
Work life balance	B12,B17,B18,B23
Fame and fortune	B22 and B20, respectively

Figure 13.1.2 : Categorisation of the questions in Section B

Section B: 'My Future job'

In our original report we had subdivided the 26 items in this section into 6 categories as shown in Table 13.1.2. We have again done this and our results are shown below.

Fame and Fortune

The issue, which attracted the highest response, was B20 'earning lots of money' with more than 90% agreeing that this was important in the overall survey. With SG Science pupils highest Likert scores were obtained for those who visited science centres most often. Similarly for B22 'Becoming famous' the Likert score increased from 2.69 to 2.83.

Looking at the three science pupils the opposite was observed. Interest in earning lots of money waned for those who visited often and the wish to become famous fell markedly from over 55% to just 30%.

Relationship with other people at work

SG Science pupils become more interested in working with people as part of a team and helping them with increasing visits to science centres. Strangely they also become more interested in working independently of people and becoming 'the boss' at work.

Those taking the three sciences become less interested in controlling people and slightly more interested in helping other people.

		Three science group					SG Science group						
Visits to science centres (1-never, 4- often)		1	2	3	4	Diff 1-4	1	2	3	4	Diff 1-4		
Topic	Number	15	57	94	35		83	94	67	40			
B01	Working with people rather than things	3.27	3.16	3.21	3.14	0.12	2.76	2.83	2.82	3.13	-0.37	X	
B02	Helping other people	3.13	3.12	3.27	3.37	-0.24	2.73	2.88	2.90	3.33	-0.59	X	
B14	Working independently of other people	2.50	2.58	2.46	2.43	0.07	2.43	2.53	2.82	2.98	-0.54	X	
B21	Controlling other people	2.60	2.37	2.38	2.23	0.37	#	2.24	2.46	2.50	2.40	-0.16	
B24	Becoming 'the boss' at my job	2.93	2.53	2.62	2.83	0.10	2.63	2.87	2.72	3.05	-0.42	X	
B26	Working as part of a team with people around me	3.07	3.02	3.10	3.06	0.01	2.77	2.82	2.91	3.28	-0.51	X	
B03	Working with animals	1.80	2.27	2.38	2.37	-0.57	X	1.95	2.07	2.50	2.85	-0.90	X
B04	Working in the area of environmental protection	1.53	1.75	2.05	2.11	-0.58	X	1.75	1.86	2.08	2.35	-0.60	X
B05	Working with something easy and simple	2.07	1.96	1.90	1.63	0.44	#	2.18	2.53	2.50	2.60	-0.42	X
B06	Building or repairing objects using my hands	1.53	1.86	2.13	1.71	-0.18	1.99	2.30	2.45	2.45	-0.46	X	
B07	Working with machines or tools	1.87	2.09	2.05	1.86	0.01	2.27	2.31	2.50	2.63	-0.36	X	
B19	Working where something new and exciting happens	3.20	3.30	3.32	3.44	-0.24	2.67	2.73	2.88	2.92	-0.25		
B08	Working artistically and creatively in art	2.00	1.89	1.96	2.03	-0.03	1.83	2.21	2.31	2.53	-0.69	X	
B10	Making, designing or inventing something	2.53	2.53	2.61	2.74	-0.21	2.13	2.46	2.66	2.93	-0.79	X	
B11	Coming up with new ideas	2.40	2.89	3.01	3.20	-0.80	X	2.51	2.63	2.76	3.18	-0.67	X
B09	Using my talents and abilities	3.20	3.51	3.62	3.69	-0.49	X	2.81	3.10	3.24	3.25	-0.44	X
B13	Making my own decisions	3.40	3.33	3.33	3.57	-0.17	3.05	3.31	3.22	3.48	-0.43	X	
B15	Working with something I find important and meaningful	3.73	3.28	3.51	3.60	0.13	2.90	2.96	3.09	3.20	-0.30		
B16	Working with something that fits my attitudes and values	3.33	3.47	3.48	3.56	-0.23	3.04	3.06	3.12	3.38	-0.34		
B25	Developing or improving my knowledge and abilities	3.40	3.49	3.53	3.63	-0.23	2.63	2.99	3.10	3.15	-0.52	X	
B17	Having lots of time for my family	3.00	3.09	3.10	3.12	-0.12	3.01	3.06	3.24	3.63	-0.61	X	
B18	Working with something that involves a lot of travelling	2.47	2.25	2.36	2.43	0.04	2.22	2.29	2.38	2.58	-0.35	X	
B23	Having lots of time for my interests and activities	3.47	3.11	3.15	3.09	0.38	#	2.95	3.09	3.15	3.45	-0.50	X
B12	Having lots of time for my friends	3.07	3.21	2.95	2.89	0.18	2.93	3.17	3.15	3.73	-0.80	X	
B20	Earning lots of money	3.60	3.53	3.34	3.26	0.34	#	3.64	3.62	3.67	3.80	-0.16	
B22	Becoming famous	2.67	2.16	2.29	2.11	0.55	#	2.69	2.71	2.91	2.83	-0.14	
	Mean Likert score	2.76	2.76	2.81	2.81	-0.05		2.57	2.72	2.83	3.04	-0.47	

Figure 13.1.3: Likert scores for Section B for the three science and SG science groups.

(# > +ve difference, x > -ve difference)

Work nature and context

Both groups, especially SG Science pupils, become much keener to work with animals and working in environmental protection becomes slightly more appealing.

Working with something easy and simple becomes less interesting for the three science group who visit centres most often but becomes more relevant for the SG science group who visit most often. The SG science group who visit often are keener to work with their hands and with machines than those who never visit, whereas with the three science group no big difference is observed. With both groups interest in working where something new and exciting happens increases with visits.

Creativity at work

The SG Science group who visit science centres most often are much more interested in creative activities, are keen to work artistically, design and invent as well as to come up with new ideas than those who seldom visit.

The three science people who have visited science centres often are also much keener to come up with new ideas than those who never visit.

Personal satisfaction from the job

Both groups show an increase in interest in all topics in this category but it is much more marked for the SG Science group who visit frequently.

Work life balance

The SG Science group show increased interest for all topics in this category whereas the three science group do not display this and in fact show a decrease in interest especially in having a lot of time for interests and activities.

13.2 Section D: 'Me and the Environmental Challenges'

This section consists of 18 questions, reviewed here briefly to compare the views of the three sciences group and those taking SG Science with the number of visits to science centres.

ASPECTS COVERED	Questions
Importance and global consequences of environmental issues	D2,D3,D4,D7,D8,D9,D14
Personal and national responsibilities in addressing problems	D1,D5,D6,D10,D11,D12,D13
Views on animal rights and human intervention in the environment	D15,D16,D17,D18

Figure 13.2.1 Categorisation of the questions in Section D

The actual questions are collected, in the above groupings, in Figure 13.2.1 where mean Likert scores are given, for pupils, each of the four categories of visits to science centres (1-for never and 4 for frequent).

Importance and global consequences of environmental issues

In all items here the SG Science pupils who visit science centres often agree more with the given statements even although they may appear contradictory, so while they are more optimistic about the future, think that environmental problems are exaggerated, can be solved and that people worry too much, they also think that these problems seem to make the future bleak and hopeless. Those who visit science centres often are most positive that we can still find solutions to our environmental problems.

The opposite trend is noticed with the three science people, where those who visit often appear to have a more negative attitude towards what will happen to the environment. They do not agree that the problems are exaggerated, or that science and technology can solve all these

problems or that we worry too much. Their opinion of whether environmental problems can be solved without big changes in our way of living is largely unchanged by science centre visits. Although their score has fallen with visits to centres they still remain optimistic about the future and agree that there is still time to solve our environmental problems.

Qu	IMPORTANCE and GLOBAL CONSEQUENCES	Three Sciences				1-4	SG Science				1-4
		1	2	3	4	Difference	1	2	3	4	Difference
D02	Environmental probs make the future of the world look bleak & hopeless	2.87	2.72	2.66	2.50	0.37	2.21	2.57	2.69	2.68	-0.46
D03	Environmental problems are exaggerated	2.47	2.26	2.04	2.20	0.27	1.97	2.28	2.13	2.39	-0.42
D04	Science & technology can solve all environmental problems	2.47	2.16	2.20	2.20	0.27	2.03	2.01	2.06	2.58	-0.55
D07	We can still find solutions to our environmental problems	3.50	3.40	3.40	3.68	-0.18	2.09	2.59	2.85	2.95	-0.86
D08	People worry too much about environmental problems	2.27	2.39	2.15	1.97	0.30	2.5	2.47	2.4	2.78	-0.28
D09	Env probs can be solved without big changes in our way of living	2.47	2.36	2.6	2.57	-0.10	2.06	2.29	2.6	2.35	-0.29
D14	I am optimistic about the future	3.53	3.00	3.15	3.11	0.42	2.42	2.46	2.58	2.74	-0.32
PERSONAL AND NATIONAL RESPONSIBILITIES											
D01	Threats to the environment are not my business	2.27	1.89	1.85	1.43	0.84	2.1	2.32	2.34	2.28	-0.18
D05	I'm willing to have env probs solved even by sacrificing many goods	2.73	2.39	2.59	2.79	-0.06	1.63	2.04	2.04	2.55	-0.92
D06	I can personally influence what happens with the environment	1.93	2.45	2.49	3.14	-1.21	1.81	1.99	2.18	2.38	-0.57
D10	People should care more about protection of the environment	3.40	3.30	3.27	3.60	-0.20	2.27	2.63	2.95	3.10	-0.83
D11	Rich countries should solve the world's environmental problems	2.60	2.75	2.74	3.00	-0.40	2.12	2.57	2.52	2.78	-0.66
D12	Each of us can make a significant contribution to enviro protection	3.00	3.04	3.28	3.49	-0.49	2.25	2.46	2.78	3.00	-0.75
D13	Environmental problems should be left to the experts	2.33	1.84	1.74	1.77	0.56	2.38	2.43	2.35	2.50	-0.12
ANIMAL RIGHTS AND HUMAN INTERVENTION											
D15	Animals should have the same right to life as people	3.13	3.20	3.06	3.17	-0.04	2.46	2.91	2.89	3.53	-1.07
D16	It's right to use animals in medical expts if this can save humans	3.20	2.07	2.39	2.77	0.43	1.93	2.13	2.11	2.05	-0.12
D17	Nearly all human activity is damaging for the environment	2.36	2.14	2.27	2.11	0.25	2.00	2.31	2.22	2.61	-0.61
D18	The natural world is sacred and should be left in peace	2.80	2.77	2.60	2.71	0.09	2.29	2.50	2.78	2.95	-0.66

Figure 13.2.2: Mean Likert for questions on the environment according to qualifications and visits to science centres. (Numbers in red indicate a positive value)

Personal and National Responsibilities

The three science pupils who visit often agree that they can personally influence what happens with the environment, think that they can make a positive contribution and do not think that problems should be left to experts. The three science group as a whole is quite willing to sacrifice goods to save the environment and this view does not alter much with the number of visits to science centres.

The SG science pupils on the other hand become more prepared to give up goods after frequent visits to science centres. They also agree more strongly that people should care more for the environment, think that they can influence more what happens and think that they can make a significant contribution when they visit science centres often.

Both pupil groups agree more that rich countries should solve the world's environmental problems after visits.

Animal Rights and Human Intervention

It is difficult to draw any conclusions for the three science group. For two of the topics (D15 and D18) there is not much change in views with the number of visits and for the other two items the Likert scores vary in a non-uniform manner.

For the SG Science pupils all scores are higher after visits to centres and those who visit frequently agree much more strongly that animals should have the same rights to life as humans. They also think that nearly all human activity is damaging the environment and that the natural world should be left in peace.

13.3 Section F- My Science Classes

Visits to science centres do not alter the opinion of both groups that science is not a difficult subject and all groups score over 2.50 for *school science is rather easy for me*, the only exception being the SG Science group who have never visited a science centre.

Interest in school science is much higher for those who have visited science centres for both groups. Those who visit science centres often tend to like science better than most subjects especially those who take the three sciences.

The perceived usefulness of school science is investigated in F4, F7, F8 and also in F11, F12 and F13.

Those taking the three sciences who never visit science centres already think that school science has opened their eyes to new and exciting jobs, will help them in everyday life and will improve their career prospects, but these views are much enhanced in those who visit science centres. Similarly those who visit science centres have an increased awareness of the importance of science to their way of living, to their health and appreciation of nature over those who have never visited.

Those taking SG Science show a similar picture but start from a lower baseline.

The same trends are shown in topics F9 and F10 which ask if school science has made pupils more curious, critical and sceptical.

The three science group are the only ones who show a positive response to the question F14 'I would like to become a scientist', and again those who visit most often are keenest. Although responses are more positive for those taking SG Science who visit centres often scores are still very low.

The SG Science group has shown an interest in technology topics in other parts of this survey and so a more positive response to F16 'I would like to get a job in technology'. This is not found for any group, except perhaps for the SG science group who visit most often where the Likert score is 2.36 (just over 45% giving a positive response).

Item	STATEMENT	Three sciences					SG Science				
		1	2	3	4	Difference	1	2	3	4	Difference
F01	School science is a difficult subject	2.00	2.07	1.95	2.03	-0.03	1.95	2.00	2.18	1.98	-0.02
F02	School science is interesting	3.00	3.05	3.31	3.66	-0.66	2.25	2.43	2.70	2.98	-0.72
F03	School science is rather easy for me	2.53	2.68	2.71	2.71	-0.18	2.29	2.57	2.53	2.78	-0.49
F04	School science has opened my eyes to new and exciting jobs	2.67	2.81	2.99	3.26	-0.59	1.96	1.94	2.11	2.59	-0.63
F05	I like school science better than most other subjects	3.07	2.82	3.02	3.26	-0.19	1.75	1.90	1.95	2.21	-0.46
F06	I think everybody should study science at school	2.40	2.77	2.88	3.23	-0.83	1.94	2.26	2.45	2.82	-0.88
F07	The things I learn in science at school will be helpful in my everyday life	2.53	2.89	3.15	3.29	-0.75	1.99	2.36	2.63	2.85	-0.86
F08	I think the science I learn at school will improve my career chances	3.13	3.54	3.76	3.86	-0.72	2.24	2.40	2.44	2.70	-0.46
F09	School science has made me more critical and sceptical	2.43	2.50	2.71	2.91	-0.49	1.78	2.02	2.26	2.46	-0.68
F10	School science has increased my curiosity about things we can't explain	2.53	2.91	3.18	3.37	-0.84	1.96	2.10	2.26	2.53	-0.56
F11	School science has increased my appreciation of nature	2.20	2.46	2.74	2.74	-0.54	1.75	2.11	2.35	2.49	-0.74
F12	School science has taught me the importance of science to our way of living	2.33	2.63	3.03	3.00	-0.67	1.80	2.20	2.37	2.49	-0.69
F13	School science has taught me how to take better care of my health	2.40	2.56	2.69	2.66	-0.26	2.12	2.66	2.56	2.73	-0.60
F14	I would like to become a scientist	2.53	2.07	2.60	3.12	-0.58	1.40	1.47	1.62	1.95	-0.55
F15	I would like to have as much science as possible at school	2.40	2.50	2.76	3.34	-0.94	1.83	1.85	1.91	2.13	-0.29
F16	I would like to get a job in technology	1.73	1.89	1.97	2.17	-0.44	1.63	1.74	1.94	2.36	-0.73

Figure 13.3.1: Mean Likert scores for Section F against the number of visits to science centres.

13.4 Section G: Opinions about Science and Technology

The two main conclusions drawn from our original S3 study on this section were:

- doubt whether science is net beneficial: by a small majority, overall, pupils did not agree that "*the benefits of science are greater than the harmful effects it could have*" - the proportion agreeing with the statement varied between two-thirds and one-third for subgroups following different study routes
- lack of trust in scientists: under 17% of pupils felt able to agree that "*we should always trust what scientists have to say*" - we regard this as perhaps the crucial obstacle for those seeking to enhance public understanding of science, and a wake-up call to the profession for scientific controversies to be debated in more carefully measured and objective terms

Let us look to see if pupils visiting science centres have different perceptions or if they in fact share these views.

From Table 13.4.1 it will be noted that for the three-science group trust in what scientists have to say remains at the same level regardless of visiting science centres. There is a slight improvement in the level of trust in scientists by those SG Science pupils who visit science centres but views remain negative.

More pupils who visit science centres often agree that *"the benefits of science are greater than the harmful effects it could have"* than those who never visit and this occurs both for the three science group as well as SG Science pupils. The proportion of those agreeing with the statement increased from 25% to 58% for SG science and from 50% to 68% for the three science pupils.

	Three sciences					SG Science				
	15	57	94	35		83	94	67	40	
Likert score for those who: 1- never visit and 4- those who visit often	1	2	3	4	Diff	1	2	3	4	Diff
G1: Science & technology are important for society	3.20	3.07	3.37	3.51	-0.31	1.93	2.56	2.52	2.70	-0.77
G2: Science & technology will find cures to diseases such as HIV/AIDS, cancer, etc	3.33	3.24	3.40	3.57	-0.24	1.96	2.55	2.61	2.69	-0.73
G3: Thanks to science & technology, there'll be greater opportunities for future generations	3.27	3.22	3.44	3.66	-0.39	1.95	2.26	2.22	2.63	-0.67
G4: Science & technology make our lives healthier, easier & more comfortable	2.87	3.04	3.05	3.40	-0.53	1.79	2.23	2.19	2.45	-0.66
G5: New technologies will make work more interesting	3.13	2.95	3.16	3.31	-0.18	2.13	2.40	2.47	2.75	-0.62
G6: The benefits of science are greater than the harmful effects it could have	2.50	2.70	2.67	2.86	-0.36	1.86	2.16	2.24	2.43	-0.56
G7: Science & technology will help eradicate poverty and famine in the world	2.69	2.33	2.44	2.80	-0.11	1.91	2.37	2.71	2.47	-0.56
G8: Science & technology can solve nearly all problems	2.50	2.00	1.99	2.17	0.33	2.16	2.57	2.66	2.72	-0.56
G9: Science & technology are helping the poor	2.07	2.09	2.13	2.46	-0.39	1.89	2.24	2.15	2.43	-0.53
G10: Science & technology are the cause of the environmental problems	2.20	2.52	2.44	2.34	-0.14	1.90	2.24	2.35	2.38	-0.48
G11: A country needs science & technology to become developed	2.60	2.88	2.88	3.03	-0.43	2.11	2.52	2.68	2.58	-0.47
G12: Science & technology benefit mainly the developed countries	2.43	2.87	2.89	2.80	-0.37	2.49	2.77	2.86	2.95	-0.46
G13: Scientists follow the scientific method that always leads to the correct answers	2.08	2.07	2.12	2.14	-0.07	1.75	1.93	2.03	2.21	-0.46
G14: We should always trust what scientists have to say	1.67	1.77	1.68	1.66	0.01	1.89	2.17	2.43	2.35	-0.46
G15: Scientists are neutral and objective	2.20	2.14	2.32	2.38	-0.18	1.93	2.27	2.29	2.33	-0.41
G16: Scientific theories develop and change all the time	2.93	3.04	3.26	3.40	-0.47	2.12	2.18	2.37	2.25	-0.13

Figure 13.4.1: Likert scores for Section G for SG Science and the three science pupils with visits to science centres (number in red indicates the only +ve score)

From the Table 13.4.1 it is seen that generally pupils who visit science centres hold more positive views about science and technology and for the three science group Likert scores rise from 2.6 to 2.8 and for the SG Science pupils there is an increase from a rather negative 2.0 to the 50% mark of 2.5.

Generally the three science group believe that science and technology are important for society, will make lives easier and healthier, will help cure diseases and will help eradicate poverty and these views are reinforced by visits to science centres. The SG Science pupils who visit science centres agree with these statements whereas those who never visit science centres tend overall not to agree.

No group really believes that science and technology are helping the poor and SG Science groups are doubtful if a country needs science and technology in order to develop, although the three science people think that a country does need science and technology to become developed, agreement becoming stronger with the number of visits.

Conclusions

Pupils who visit science centres often:

- are more prepared to accept personal and national responsibility for the environment
- think that school science helps them in everyday life, with career chances, care of their health etc.
- express more desire to become scientists than those who seldom visit
- are much keener to come up with new ideas
- who are taking the three sciences at school are more inclined to think that they can take personal responsibility for the environment, whereas the SG Science group show an increasing interest in sacrificing goods to help solve environmental problems.



ROSE

The Relevance of Science Education

This is part of a questionnaire which has been given to pupils in many different countries.

If there is a question you do not understand, just leave it blank. If you are in doubt, you may ask the teacher, since this is not a test!

For most questions, you simply put a cross in the box or picture

X

THANK YOU!

Your answers will be a big help.

START HERE:

I am a girl boy

I am _____ years old

I attend _____ (write the name of your school)

I am in Primary _____ (5, 6,7.....)

This questionnaire, in a slightly modified form, was the one given to primary school pupils. The sections and the question numbers have been altered to match with those of the full questionnaire which has been used internationally and also by S3 pupils in 2006.

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A. What I want to learn about

How interested are you in learning about the things below?

	<i>Not interes- ted</i>		<i>Very interes- ted</i>	
1. Stars, planets and the universe	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Chemicals and what they do	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Clouds, rain and the weather	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. The human body	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. Dinosaurs, how they lived and why they died out	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. How plants grow	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24. Earthquakes and volcanoes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
27. Dangerous and threatening animals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
28. Poisonous plants in my area	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
31. Explosive chemicals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
34. How it feels to be weightless in space	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
37. What to eat to keep healthy and fit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
40. How to exercise to keep the body fit and strong	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
44. Rockets, satellites and space travel	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
47. How petrol and diesel engines work	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Section C

1. How to make plastics and materials from oil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. How things like radios and televisions work	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. How mobile phones can send and receive messages	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. How computers work	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. The possibility of life outside earth	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Unsolved mysteries in outer space	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Why we dream while we are sleeping, and what the dreams may mean	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. Ghosts and witches, and whether they may exist	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16. Why the stars twinkle and the sky is blue	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

17. Why we can see the rainbow

*Not
interes-
ted*

*Very
interes-
ted*

Section E

1. Patterns in leaves and flowers

3. The ozone layer

4. Ways in which humans can cause climate change

7. How to control diseases

8. Cancer, what we know and how we can treat it

10. How to perform first-aid

12. How alcohol and tobacco might affect the body

14. The possible dangers of mobile phones

21. New sources of energy from the sun, wind, tides,

(A)23. How meteors & comets may cause disasters on earth

24. Animals in my area

25. Plants in my area

26. Detergents, soaps and how they work

29. First landing on the moon & the history of space travel

37. Famous scientists and their lives

38. Big mistakes in research and inventions

B. My future job

What kinds of things would you want to do in your future job?

*Not
important*

*Very
important*

2. Help other people

3. Work with animals

7. Work with machines or tools

10. Make, design or invent things

- | | | | | | |
|-----|----------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 11. | Come up with new ideas | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 12. | Have lots of time for my friends | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 18. | Travel to other places | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 20. | Earn lots of money | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 22. | Become famous | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

D. Me and the environmental challenges

State how much you agree with the sentences below about problems with the environment

- | | | <i>Disagree</i> | | <i>Agree</i> | |
|-----|--|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. | Threats to the environment are not my business | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. | I am willing to help save the environment even if it means giving up some of my belongings | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. | People worry too much about the environment | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 16. | It is right to use animals in medical experiments if this can save human lives | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

F My science classes

Show how much you agree or disagree with the sentences below about the science you have at school.

- | | | <i>Disagree</i> | | <i>Agree</i> | |
|-----|--|--------------------------|--------------------------|--------------------------|--------------------------|
| 2. | School science is interesting | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. | School science is rather easy for me to learn | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. | I like school science better than most other subjects | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. | The things that I learn in science at school will be helpful in my everyday life | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 14. | I would like to become a scientist | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

G. What I think about Science and Technology
How much do you agree with the following sentences?

		<i>Disagree</i>		<i>Agree</i>	
1.	Science and technology are important for society	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.	Science and technology will find cures to diseases such as cancer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.	Science and technology make our lives healthier, easier and more comfortable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.	The advantages of science are greater than the harmful effects it could have	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.	Science and technology will help to get rid of poverty and hunger in the world	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10.	Science and technology are the cause of problems in the world such as climate change	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11.	A country needs science and technology to become richer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14.	We should always trust what scientists have to say	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

H. My life out-of-school
How often have you done this outside school?

I have ...

		<i>Never</i>		<i>Often</i>	
13.	watched nature programmes on TV or in a cinema	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17.	planted seeds and watched them grow	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
31.	used a camera	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
32.	made a bow and arrow, or catapult	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
35.	made a model such as toy plane or boat etc	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
36.	used a science kit (like for chemistry or electricity)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
38.	recorded on video, DVD or tape recorder	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
43.	used a measuring ruler, tape or stick	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- | | | | | | |
|-----|---------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 44. | used a mobile phone | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 46. | searched the internet for information | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 47. | played computer games | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 50. | sent or received e-mail | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

H. What do scientists do?

Write down three jobs in which you think the person doing the job needs to know lots of science.

1.
2.
3.

4. If you do not want to be a scientist what do you want to be when you are grown up?

.....

J. How many books are there in your home?

(Please complete only one box.)

- None
- 1-10 books
- 11-50 books
- 51-100 books
- 101-250 books
- 251-500 books
- More than 500 books

Thanks for completing this Questionnaire.

school number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Number in class		24	47	19	28	27	25	27	16	22	22	28	22	17	25	18	28	35
A27. Brutal, dangerous and threatening animals	x	2.96	3.11	2.32	2.82	3.04	3.28	2.85	7.3.13	2.86	3.64	3.36	3.73	3.47	3.32	2.72	2.36	3.17
C08. The possibility of life outside earth	x	2.96	2.94	3.16	2.79	2.70	3.29	5.2.37	17.2.87	18.3.14	2.3.50	2.2.96	17.3.59	2.2.65	17.2.68	14.3.50	2.3.32	3.2.74
A31. Explosive chemicals	x	3.13	3.32	3.00	2.46	2.96	3.32	3.00	3.3.47	3.4.8	3.4.3	3.14	11.3.55	3.3.25	2.3.28	2.3.59	3.3.50	3.0.0
C13. Why we dream while we are sleeping, and what the dream	x	3.08	2.98	2.47	3.07	2.56	3.21	11.3.15	2.3.38	3.3.00	5.3.27	4.3.29	6.3.23	7.3.12	3.3.12	5.3.11	8.3.25	4.3.11
A34. How it feels to be weightless in space	x	2.83	12.3.06	3.2.63	16.2.57	11.2.37	18.3.28	9.2.26	21.2.67	26.3.14	3.3.23	5.3.00	15.3.50	4.3.06	5.2.76	10.3.17	5.3.18	5.3.43
A23. How meteors and comets may cause disasters	x	2.67	14.2.68	17.2.16	28.2.42	18.2.67	5.3.29	6.2.11	30.2.50	32.2.86	13.3.23	6.3.07	13.2.86	18.2.65	18.2.44	23.3.17	6.2.64	15.2.80
A28. Poisonous plants in my area		2.25	31.2.43	28.1.95	31.2.04	31.1.85	33.2.63	32.2.22	24.2.53	31.2.14	34.3.18	7.2.68	26.2.50	31.2.53	24.2.24	29.2.22	34.2.54	18.2.54
A24. Earthquakes and volcanoes	x	2.46	26.2.96	5.3.42	1.2.82	3.2.63	7.3.32	4.2.67	13.3.20	6.2.95	8.3.09	8.3.25	8.3.27	5.2.56	23.2.76	11.3.22	3.3.14	6.2.94
C14. Ghosts and witches, and whether they may exist	x	2.58	18.2.62	18.3.11	5.2.37	19.2.37	19.3.08	14.2.52	14.2.75	20.2.41	29.3.09	9.3.29	7.3.00	15.2.18	35.2.84	9.2.72	20.2.71	12.2.74
E07. How to control epidemics and diseases		2.63	17.2.57	21.2.21	26.2.14	25.2.30	21.3.24	10.2.52	15.2.56	29.2.43	28.3.05	11.2.96	18.3.18	9.2.94	7.2.32	27.3.00	12.2.68	13.2.71
E38. Big blunders and mistakes in research and inventions		2.54	21.2.72	16.1.84	36.2.46	17.2.19	26.3.29	7.2.04	32.2.88	16.2.95	6.3.05	10.3.00	16.3.09	14.2.71	13.2.48	22.2.61	24.2.46	21.2.34
A14. Dinosaurs, how they lived and why they died out	x	2.75	13.2.72	15.3.00	8.2.50	13.2.44	13.3.12	13.2.30	20.2.27	36.3.09	4.3.00	12.2.57	29.2.09	37.3.00	6.2.60	17.2.94	15.2.71	11.2.74
C10. Unsolved mysteries in outer space		2.88	8.2.83	13.2.58	18.2.79	7.2.41	16.3.16	12.2.11	27.2.63	27.2.95	7.3.00	13.2.86	22.3.14	11.2.59	22.2.72	12.3.11	7.3.11	8.2.91
A40. How to exercise to keep the body fit and strong	x	2.92	6.2.89	9.3.32	3.3.00	2.2.67	6.2.72	28.3.22	1.2.93	15.2.73	19.2.91	14.3.36	4.3.14	10.2.94	8.2.88	8.3.06	10.2.82	10.2.94
E08. Cancer, what we know and how we can treat it	x	2.50	24.2.85	10.2.79	13.2.59	10.2.41	17.3.35	2.2.70	12.3.13	10.2.59	27.2.82	15.3.37	2.3.18	8.2.88	11.2.48	21.2.94	14.2.64	14.3.06
E24. Animals in my area	x	2.83	10.2.96	6.3.00	7.2.71	8.2.81	3.3.04	15.2.93	5.3.25	5.2.86	11.2.77	16.3.18	10.2.68	21.2.94	10.3.24	3.2.61	25.2.96	9.3.03
E10. How to perform first-aid and use basic medical equipment	x	2.88	9.2.79	14.2.84	11.2.46	16.2.56	11.2.80	24.2.74	10.3.44	2.2.82	15.2.77	17.3.39	4.3.09	13.3.12	4.2.52	20.2.78	18.2.50	19.3.00
A37. What to eat to keep healthy and fit	x	2.92	5.2.85	11.2.74	14.2.82	5.2.63	8.2.72	29.2.96	4.2.71	24.2.64	22.2.73	18.2.89	21.2.55	30.2.88	12.2.64	15.3.00	11.2.43	24.2.80
C06. How mobile phones can send and receive messages	x	2.83	11.2.57	20.2.63	17.2.68	9.2.30	20.2.88	22.2.85	8.3.00	13.2.82	16.2.68	19.3.32	5.2.77	20.2.38	28.2.96	6.2.72	22.2.36	27.2.31
C05. How things like radios and televisions work		2.63	16.2.26	34.2.37	20.2.36	20.2.26	24.2.80	25.2.37	18.2.87	19.2.59	25.2.64	20.3.07	14.2.55	29.2.71	15.2.56	19.2.28	31.2.46	23.1.91
E29. The first landing on the moon and the history of space exploration		2.08	33.2.45	27.2.21	27.2.29	22.1.89	32.3.00	18.2.00	33.2.63	28.2.64	23.2.50	21.2.96	19.2.64	23.2.35	29.2.72	13.2.88	16.2.36	29.2.77
A44. Rockets, satellites and space travel	x	2.50	23.2.43	30.2.32	23.2.46	14.2.04	29.3.36	1.2.11	29.2.20	38.2.64	24.2.45	22.2.61	28.2.82	19.2.29	32.2.33	26.2.28	33.2.32	30.2.74
C07. How computers work		2.88	7.2.49	24.2.79	12.2.54	12.2.59	9.3.00	16.2.93	6.3.07	11.2.68	21.2.41	23.3.11	12.3.27	6.2.59	20.2.64	16.2.56	28.2.46	22.2.77
A01. Stars, planets and the universe		2.63	15.2.45	26.1.68	40.2.11	29.2.30	22.2.88	23.2.19	25.2.13	39.2.59	26.2.36	25.2.71	24.2.41	32.2.29	31.1.84	40.2.89	17.2.61	16.2.89
A47. How petrol and diesel engines work		2.30	29.2.36	32.2.37	22.1.93	32.1.85	34.2.20	37.2.15	26.2.33	34.2.14	32.2.36	26.2.00	38.3.09	12.2.35	30.2.28	28.2.06	36.2.07	34.2.38
E12. How alcohol and tobacco might affect the body	x	2.50	25.2.89	8.2.95	9.2.11	28.2.44	14.2.76	27.2.70	11.3.19	7.2.82	14.2.36	24.3.12	9.2.86	17.2.71	14.3.20	4.3.17	4.2.56	17.2.86
E14. The possible radiation dangers of mobile phones and computers	x	2.42	28.2.53	22.2.94	10.2.14	26.2.15	27.2.60	33.2.81	9.3.31	4.2.86	10.2.32	27.2.64	27.2.59	25.2.47	26.2.92	7.2.61	27.2.39	26.2.66
E03. The ozone layer and how it may be affected by humans		2.25	32.2.36	33.1.95	33.2.07	30.2.26	25.2.48	35.1.93	36.2.25	37.2.68	20.2.32	28.2.21	34.2.68	22.2.53	25.1.96	34.2.67	23.2.07	35.2.37
A02. Chemicals, their properties and how they react		2.50	22.2.83	12.2.68	15.1.71	40.2.30	23.2.96	19.2.23	22.2.73	23.2.91	9.2.27	29.2.68	25.2.95	16.2.94	9.1.88	38.3.11	9.3.14	7.2.77
C01. How crude oil is converted to other materials, like plastics and fuels		2.57	19.2.60	19.1.79	37.1.82	37.1.96	31.2.68	30.2.00	34.3.00	14.2.29	30.2.17	30.2.15	36.2.59	26.2.12	37.2.44	24.2.78	19.2.14	33.2.53
C16. Why the stars twinkle and the sky is blue		2.04	36.2.47	25.2.21	25.2.14	27.1.96	30.2.92	20.2.11	28.3.06	12.2.14	33.2.18	31.2.32	32.2.55	28.2.47	27.2.36	25.2.28	32.2.36	28.2.89
E04. The greenhouse effect and how it may be changed by humans		2.46	27.2.38	31.1.95	32.2.32	21.2.48	12.3.00	17.2.37	19.2.75	21.2.09	35.2.18	32.2.82	23.2.55	27.2.65	19.2.16	30.2.61	26.2.50	20.2.49
E21. New sources of energy from the sun, wind, tides, waves, etc.		2.54	20.2.17	36.2.11	29.2.25	23.2.41	15.2.92	21.2.11	31.2.75	22.2.77	18.2.18	33.2.50	30.2.27	35.2.59	21.2.08	31.2.11	35.2.21	32.2.12
E37. Famous scientists and their lives		2.08	34.2.43	29.2.00	30.1.75	38.1.85	35.2.79	26.1.74	38.2.47	33.2.77	17.2.14	34.2.32	33.2.32	34.2.24	34.1.96	35.2.50	29.1.89	40.1.94
A07. How the human body is built and functions		2.29	30.2.52	23.2.22	24.2.21	24.1.78	36.2.64	31.2.41	16.2.87	17.2.00	39.2.09	35.2.89	20.2.32	33.2.71	16.2.04	32.3.00	13.2.39	25.2.51
E25. Plants in my area		1.88	38.2.00	39.1.74	38.1.89	33.1.67	38.1.96	41.1.96	35.2.31	35.2.05	37.2.00	36.2.04	37.1.91	38.2.24	33.1.88	39.1.72	39.1.93	39.1.83
C17. Why we can see the rainbow		2.04	35.2.24	35.2.37	21.1.86	34.2.07	28.2.60	34.2.22	23.3.19	8.2.09	36.1.95	37.2.36	31.2.62	24.2.12	38.2.60	18.2.44	30.2.21	31.2.37
A01. Symmetries and patterns in leaves and flowers		1.75	40.1.72	41.1.68	39.1.75	39.1.56	39.2.12	38.1.59	41.2.56	30.1.82	41.1.68	38.1.71	41.1.73	40.1.76	41.1.92	37.1.83	38.1.81	41.2.31
E03. The inside of the earth		1.63	41.2.04	38.1.94	35.1.82	36.1.74	37.1.96	39.1.63	40.1.73	41.1.86	40.1.59	39.2.18	35.1.73	39.2.18	36.2.00	33.1.94	37.2.00	37.2.32
E26. Detergents, soaps and how they work		1.83	39.2.09	37.1.95	34.1.86	35.1.54	40.2.30	36.1.81	37.2.69	25.2.14	31.1.45	40.1.96	39.2.14	36.1.88	40.1.92	36.1.61	41.1.96	38.2.17
A15. How plants grow and reproduce		1.92	37.1.91	40.1.67	41.1.68	41.1.48	41.1.96	40.1.74	39.1.93	40.2.05	38.1.36	41.1.79	40.1.32	41.1.88	39.1.80	41.1.67	40.2.04	36.1.71
Mean Likert score for Sections ACE		2.42	2.50	2.36	2.24	2.18	2.77	2.29	2.69	2.53	2.48	2.68	2.64	2.50	2.40	2.60	2.46	2.53

Appendix 2: Table of ACE results for individual schools

Topic	girl	boy	all	Domain	What I want to learn about	boy rank	girl rank
A32	2.47	3.04	2.74	B	Biological and chemical weapons and what they do to the body	1	15
A27	2.72	2.98	2.84	B	Brutal, dangerous and threatening animals	2	5
A09	2.63	2.91	2.76	B	Sex and reproduction	3	9
A12	2.61	2.77	2.68	B	Cloning of animals	4	10
A20	2.58	2.60	2.59	B	How animals use colours to hide, attract or scare	5	12
A13	2.63	2.58	2.60	B	Animals in other parts of the world	6	8
E16	2.81	2.54	2.68	B	How to protect endangered species of animals	7	1
E23	2.78	2.53	2.66	B	How my body grows and matures	8	3
A07	2.81	2.50	2.66	B	How the human body is built and functions	9	2
E32	2.66	2.50	2.58	B	How gene technology can prevent diseases	10	7
A28	2.18	2.36	2.27	B	Poisonous plants in my area	11	18
E24	2.50	2.30	2.41	B	Animals in my area	12	14
A08	2.59	2.29	2.45	B	Heredity, and how genes influence how we develop	13	11
E18	2.36	2.25	2.31	B	Medicinal use of plants	14	16
A10	2.50	2.23	2.38	B	Birth control and contraception	15	13
A11	2.75	2.21	2.49	B	How babies grow and mature	16	4
E22	2.13	2.13	2.13	B	How different sorts of food are produced, conserved and stored	17	19
E31	2.66	2.09	2.39	B	Biological and human aspects of abortion	18	6
E35	2.24	2.08	2.17	B	Risks and benefits of food additives	19	17
E17	1.87	1.95	1.91	B	How to improve the harvest in gardens and farms	20	20
E25	1.84	1.83	1.83	B	Plants in my area	21	21
A15	1.79	1.75	1.77	B	How plants grow and reproduce	22	22
E01	1.57	1.42	1.50	B	Symmetries and patterns in leaves and flowers	23	23
A25	2.64	2.88	2.75	E	Tornados, hurricanes and cyclones	1	2
A23	2.45	2.87	2.64	E	How meteors or asteroids may cause disasters on earth	2	5
A24	2.48	2.74	2.60	E	Earthquakes and volcanoes	3	3
A14	2.27	2.69	2.47	E	Dinosaurs, how they lived and why they died out	4	6
A06	2.46	2.55	2.50	E	The origin and evolution of life on earth	5	4
A03	2.01	2.13	2.06	E	The inside of the earth	6	9
C18	2.64	2.11	2.39	E	Properties of gems and crystals and how these are used for beauty	7	1
A04	2.02	2.08	2.05	E	How mountains, rivers and oceans develop and change	8	7
E19	1.91	1.93	1.92	E	Organic farming without use of pesticides and fertilisers	9	10
A05	2.02	1.91	1.97	E	Clouds, rain and the weather	10	8
E33	1.72	1.81	1.76	E	Benefits and possible hazards of modern methods of farming	11	11
A33	2.65	3.02	2.82	H	The effect of electric shocks and lightning on the body	1	18
E08	3.27	2.92	3.10	H	Cancer, what we know and how we can treat it	2	2
A40	3.07	2.91	2.99	H	How to exercise to keep the body fit and strong	3	3
C13	3.31	2.89	3.11	H	Why we dream while we are sleeping, and what dreams mean	4	1
A29	2.81	2.83	2.82	H	Deadly poisons and what they do to the human body	5	12
E10	3.07	2.78	2.93	H	How to perform first-aid and use basic medical equipment	6	4
E12	2.99	2.73	2.87	H	How alcohol and tobacco might affect the body	7	5
E09	2.88	2.70	2.80	H	Sexually transmitted diseases and how to be protected	8	9
A18	2.32	2.66	2.48	H	How radioactivity affects the human body	9	24
A37	2.98	2.63	2.82	H	What to eat to keep healthy and fit	10	6
C11	2.88	2.60	2.75	H	Life and death and the human soul	11	8
E11	2.89	2.58	2.75	H	What we know about HIV/AIDS and how to control it	12	7
C15	2.82	2.57	2.71	H	Thought transference, mind-reading, sixth sense, intuition, etc.	13	11
E07	2.74	2.47	2.62	H	How to control epidemics and diseases	14	15
E05	2.55	2.45	2.50	H	What can be done to ensure clean air and safe drinking water	15	20
C14	2.84	2.45	2.66	H	Ghosts and witches, and whether they may exist	16	10
E13	2.59	2.45	2.52	H	How different narcotics might affect the body	17	19
A26	2.66	2.44	2.55	H	Epidemics and diseases causing large losses of life	18	17
E15	2.31	2.36	2.33	H	How loud sound and noise may damage my hearing	19	25
E30	1.85	2.33	2.08	H	How electricity has affected the development of our society	20	30
E03	2.19	2.23	2.21	H	The ozone layer and how it may be affected by humans	21	27

Figure: Likert scores for all ACE topics listed by domain

Appendix 3: Likert scores for A, C, E topics listed by domain

Topic	girl	boy	all	Domain	What I want to learn about	boy rank	girl rank
A16	2.25	2.21	2.23	H	How people, animals, plants and the environment depend	22	26
E04	2.14	2.17	2.16	H	The greenhouse effect and how it may be changed by humans	23	28
E06	1.91	2.16	2.03	H	How technology helps us to handle waste, garbage and sewage	24	29
A42	2.46	2.14	2.31	H	How radiation from solariums and the sun might affect the skin	25	22
C09	2.39	2.04	2.22	H	Astrology and horoscopes, and whether planets can influence humans	26	23
A38	2.75	2.01	2.40	H	Eating disorders like anorexia or bulimia	27	14
A41	2.78	2.00	2.41	H	Plastic surgery and cosmetic surgery	28	13
C12	2.48	1.88	2.20	H	Alternative therapies (acupuncture, homeopathy, yoga, healing etc)	29	21
A39	2.73	1.86	2.32	H	The ability of lotions and creams to keep the skin young	30	16
E42	2.46	2.68	2.56	N	Phenomena that scientists still cannot explain	1	1
E40	2.29	2.60	2.43	N	Inventions and discoveries that have changed the world	2	2
E41	2.18	2.59	2.37	N	Very recent inventions and discoveries in science and technology	3	3
E38	2.10	2.49	2.28	N	Big blunders and mistakes in research and inventions	4	4
E39	1.97	2.16	2.06	N	How scientific ideas sometimes challenge religion and authority	5	7
E34	2.07	2.13	2.10	N	Why religion and science sometimes are in conflict	6	5
E36	1.98	2.12	2.05	N	Why scientists sometimes disagree	7	6
E37	1.69	1.92	1.80	N	Famous scientists and their lives	8	8
A31	2.72	3.32	2.99	P	Explosive chemicals	1	1
A19	2.26	2.53	2.38	P	Light around us that we cannot see (infrared, ultraviolet)	2	6
A02	2.30	2.52	2.40	P	Chemicals, their properties and how they react	3	5
E27	1.97	2.41	2.18	P	Electricity, how it is produced and used in the home	4	10
A36	2.40	2.30	2.35	P	How the eye can see light and colours	5	2
A43	2.23	2.22	2.22	P	How the ear can hear different sounds	6	7
A17	1.94	2.21	2.06	P	Atoms and molecules	7	11
C17	2.39	2.17	2.28	P	Why we can see the rainbow	8	3
A21	2.05	2.03	2.04	P	How different musical instruments produce different sounds	9	8
E02	2.35	1.99	2.18	P	How the sunset colours the sky	10	4
E26	2.00	1.87	1.94	P	Detergents, soaps and how they work	11	9
A34	3.01	3.18	3.09	S	How it feels to be weightless in space	1	1
C08	2.67	2.95	2.80	S	The possibility of life outside earth	2	2
A22	2.33	2.83	2.56	S	Black holes, supernovas and other objects in space	3	5
A44	2.00	2.76	2.35	S	Rockets, satellites and space travel	4	9
C10	2.42	2.64	2.52	S	Unsolved mysteries in outer space	5	4
A01	2.31	2.43	2.36	S	Stars, planets and the universe	6	7
E29	2.07	2.40	2.22	S	The first landing on the moon and the history of space exploration	7	8
A35	2.32	2.33	2.32	S	How to find my way and navigate by the stars	8	6
C16	2.46	2.22	2.35	S	Why the stars twinkle and the sky is blue	9	3
A30	2.22	2.98	2.57	T	How the atom bomb functions	1	8
C07	2.35	2.91	2.61	T	How computers work	2	4
E28	1.92	2.72	2.29	T	How to use and repair everyday electrical and mechanical equipment	3	11
A47	1.78	2.71	2.22	T	How petrol and diesel engines work	4	14
C04	2.30	2.69	2.48	T	How cassette tapes, CDs and DVDs store and play sound and music	5	5
C03	2.08	2.68	2.36	T	The use of lasers for technical purposes (CD Players etc)	6	10
C06	2.52	2.65	2.58	T	How mobile phones can send and receive messages	7	2
A48	1.72	2.58	2.13	T	How a nuclear power plant functions	8	15
C05	2.12	2.54	2.31	T	How things like radios and televisions work	9	9
E21	2.27	2.52	2.39	T	New sources of energy from the sun, wind, tides, waves, etc.	10	6
E14	2.47	2.50	2.48	T	The possible radiation dangers of mobile phones and computers	11	3
E20	2.24	2.43	2.33	T	How energy can be saved or used in a more effective way	12	7
A46	2.54	2.42	2.48	T	How X-rays, ultrasound, etc. are used in medicine	13	1
A45	1.86	2.33	2.08	T	The use of satellites for communication and other purposes	14	13
C02	1.91	2.15	2.02	T	Optical instruments and how they work	15	12
C01	1.60	1.94	1.76	T	How crude oil is converted to other materials, like plastics and textiles	16	16



ROSE

The Relevance of Science Education

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This booklet has questions about you and about your experiences and interests related to science in school and outside school.

*There are no correct answers, only answers that are right for you.
Please think carefully and give answers that reflect your own thinking.*

This questionnaire is being given to students in many different countries. That is why some questions may seem strange to you. If there is a question you do not understand, just leave it blank. If you are in doubt, you may ask a teacher, since this is not a test!

For most questions, you simply colour in the appropriate circle.

The purpose of this questionnaire is to find out what students in different parts of the world think about science at school as well as in their everyday life. This information may help us to make schools better.

Your answers are anonymous, so please, do not write your name on this questionnaire.

THANKYOU!

Your answers will be a big help.

START HERE :

Shade Circles Like This--> ●
Not Like This--> ⊗ ⊕

I am a girl boy

I am years old

I live in _____
(write the name of your country)

I am studying Standard Grade / Intermediate Biology
 Chemistry
 Physics
 Science

- | | INTERESTED → |
|--|---|
| | NOT VERY |
| 45. The use of satellites for communication and other purposes | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 46. How X-rays, ultrasound, etc. are used in medicine | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 47. How petrol and diesel engines work | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 48. How a nuclear power plant functions | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |

B. My future job

How important are the following issues for your potential future occupation or job?

(Give your answer by shading the appropriate circle on each line. If you do not understand the question, leave the line blank.)

- | | IMPORTANT → |
|--|---|
| | NOT VERY |
| 1. Working with people rather than things | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 2. Helping other people | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 3. Working with animals | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 4. Working in the area of environmental protection | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 5. Working with something easy and simple | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 6. Building or repairing objects using my hands | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 7. Working with machines or tools | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 8. Working artistically and creatively in art | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 9. Using my talents and abilities | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 10. Making, designing or inventing something | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 11. Coming up with new ideas | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 12. Having lots of time for my friends | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 13. Making my own decisions | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 14. Working independently of other people | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 15. Working with something I find important and meaningful | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |

NOT VERY
IMPORTANT →

- | | IMPORTANT → |
|--|---|
| | NOT VERY |
| 16. Working with something that fits my attitudes and values | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 17. Having lots of time for my family | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 18. Working with something that involves a lot of travelling | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 19. Working at a place where something new and exciting happens frequently | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 20. Earning lots of money | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 21. Controlling other people | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 22. Becoming famous | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 23. Having lots of time for my interests, hobbies and activities | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 24. Becoming 'the boss' at my job | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 25. Developing or improving my knowledge and abilities | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 26. Working as part of a team with many people around me | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |

C. What I want to learn about

How interested are you in learning about the following?

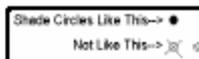
(Give your answer by shading the appropriate circle on each line. If you do not understand the question, leave the line blank.)

- | | INTERESTED → |
|---|---|
| | NOT VERY |
| 1. How crude oil is converted to other material like plastics and textiles | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 2. Optical instruments and how they work (telescope, camera, microscope etc.) | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 3. The use of lasers for technical purposes (CD players, bar-code readers etc.) | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 4. How cassette tapes, CDs and DVDs store and play sound and music | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 5. How things like radios and televisions work | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 6. How mobile phones can send and receive messages | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 7. How computers work | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |
| 8. The possibility of life outside earth | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |

NOT VERY
INTERESTED →



53651



- | | INTERESTED | | | |
|--|-----------------------|-----------------------|-----------------------|-----------------------|
| | NOT | | | VERY |
| 9. Astrology & horoscopes and whether the planets can influence human beings | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 10. Unsolved mysteries in outer space | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 11. Life and death and the human soul | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 12. Alternative therapies (acupuncture, yoga etc) and how effective they are | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 13. Why we dream while we are sleeping and what the dreams may mean | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 14. Ghosts and witches and whether they may exist | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 15. Thought transference, mind reading, sixth sense, intuition etc | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 16. Why the stars twinkle & the sky is blue | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 17. Why we can see the rainbow | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 18. Properties of gems and crystals and how these are used for beauty | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

- | | AGREE | | | |
|--|-----------------------|-----------------------|-----------------------|-----------------------|
| | Disagree | | | Agree |
| 9. Environmental problems can be solved without big changes in our way of living | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 10. People should care more about protection of the environment | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 11. Rich countries should solve the world's environmental problems | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 12. Each of us can make a significant contribution to environmental protection | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 13. Environmental problems should be left to the experts | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 14. I am optimistic about the future | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 15. Animals should have the same right to life as people | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 16. It's right to use animals in medical experiments if this can save humans | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 17. Nearly all human activity is damaging for the environment | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 18. The natural world is sacred & should be left in peace | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

D. Me and the Environmental Challenges

To what extent do you agree with the following statements about problems with the environment (pollution of air & water, overuse of resources, global changes of the climate etc)? (Give your answer by shading the appropriate circle on each line. If you do not understand the question, leave the line blank.)

- | | AGREE | | | |
|--|-----------------------|-----------------------|-----------------------|-----------------------|
| | Disagree | | | Agree |
| 1. Threats to the environment are not my business | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 2. Environmental problems make the future of the world look bleak & hopeless | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 3. Environmental problems are exaggerated | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 4. Science and technology can solve all environmental problems | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 5. I'm willing to have environm'l problems solved even by sacrificing many goods | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 6. I can personally influence what happens with the environment | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 7. We can still find solutions to our environmental problems | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 8. People worry too much about environmental problems | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

E. What I want to learn about

How interested are you in learning about the following? (Give your answer by shading the appropriate circle on each line. If you do not understand the question, leave the line blank.)

- | | INTERESTED | | | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|
| | NOT | | | VERY |
| 1. Symmetries and patterns in leaves and flowers | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 2. How the sunset colours the sky | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 3. The ozone layer and how it may be affected by humans | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 4. The greenhouse effect and how it may be changed by humans | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 5. What can be done to ensure clean air & safe drinking water | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 6. How technology helps us to handle waste, garbage and sewage | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 7. How to control epidemics and diseases | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 8. Cancer, what we know and how we can treat it | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 9. Sexually transmitted diseases and how to be protected against them | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

	INTERESTED →			
	NOT			VERY
10. How to perform first-aid and use basic medical equipment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. What we know about HIV-AIDS and how to control it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. How alcohol and tobacco might affect the body	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. How different narcotics might affect the body	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. The possible radiation dangers of mobile phones and computers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15. How loud sound and noise may damage my hearing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16. How to protect endangered species of animals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17. How to improve the harvest in gardens and farms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18. Medicinal use of plants	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19. Organic and ecological farming without use of pesticides & artificial fertilisers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20. How energy can be saved or used in a more effective way	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21. New sources of energy from the sun, wind, tides, waves etc	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
22. How different sorts of food are produced, conserved and stored	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23. How my body grows and matures	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
24. Animals in my area	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
25. Plants in my area	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
26. Detergents, soaps and how they work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
27. Electricity, how it is produced and used in the home	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
28. How to use and repair everyday electrical and mechanical equipment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
29. The first landing on the moon and the history of space exploration	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
30. How electricity has affected the development of our society	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
31. Biological and human aspects of abortion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
32. How gene technology can prevent diseases	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	INTERESTED →			
	NOT			VERY
33. Benefits and possible hazards of modern methods of farming	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
34. Why religion and science sometimes are in conflict	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
35. Risks and benefits of food additives	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
36. Why scientists sometimes disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
37. Famous scientists and their lives	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
38. Big blunders and mistakes in research and inventions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
39. How scientific ideas sometimes challenge religion, authority & tradition	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
40. Inventions and discoveries that have changed the world	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
41. Very recent inventions and discoveries in science and technology	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
42. Phenomena that scientists still cannot explain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

F. My Science Classes

To what extent do you agree with the following statements about the science that you may have had at School? (Give your answer by shading the appropriate circle on each line. If you do not understand the question, leave the line blank.)

	AGREE →			
	Disagree			Agree
1. School science is a difficult subject	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. School science is interesting	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. School science is rather easy for me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. School science has opened my eyes to new and exciting jobs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. I like school science better than most other subjects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. I think everybody should learn science at school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. The things I learn in science at school will be helpful in my everyday life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. I think that the science I learn at school will improve my career chances	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. School science has made me more critical and sceptical	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

- | | AGREE → | | | |
|---|----------|---|---|-------|
| | Disagree | | | Agree |
| 10. School science has increased my curiosity about things we can't explain | ○ | ○ | ○ | ○ |
| 11. School science has increased my appreciation of nature | ○ | ○ | ○ | ○ |
| 12. School science has shown me the importance of science for our way of living | ○ | ○ | ○ | ○ |
| 13. School science has taught me how to take better care of my health | ○ | ○ | ○ | ○ |
| 14. I would like to become a scientist | ○ | ○ | ○ | ○ |
| 15. I would like to have as much science as possible at school | ○ | ○ | ○ | ○ |
| 16. I would like to get a job in technology | ○ | ○ | ○ | ○ |

G. My opinions about Science & Technology

To what extent do you agree with the following statements?
(Give your answer by shading the appropriate circle on each line.
If you do not understand the question, leave the line blank.)

- | | AGREE → | | | |
|---|----------|---|---|-------|
| | Disagree | | | Agree |
| 1. Science & technology (Sci & Tech) are important for society | ○ | ○ | ○ | ○ |
| 2. Science & technology will find cures to diseases such as HIV/AIDS, cancer etc | ○ | ○ | ○ | ○ |
| 3. Thanks to Sci & Tech, there'll be greater opportunities for future generations | ○ | ○ | ○ | ○ |
| 4. Sci & Tech make our lives healthier, easier and more comfortable | ○ | ○ | ○ | ○ |
| 5. New technologies will make work more interesting | ○ | ○ | ○ | ○ |
| 6. The benefits of science are greater than the harmful effects it could have | ○ | ○ | ○ | ○ |
| 7. Sci & Tech will help to eradicate poverty and famine in the world | ○ | ○ | ○ | ○ |
| 8. Sci & Tech can solve nearly all problems | ○ | ○ | ○ | ○ |
| 9. Sci & Tech are helping the poor | ○ | ○ | ○ | ○ |
| 10. Sci & Tech are the cause of the environmental problems | ○ | ○ | ○ | ○ |
| 11. A country needs Sci & Tech to become developed | ○ | ○ | ○ | ○ |
| 12. Sci & Tech benefit mainly the developed countries | ○ | ○ | ○ | ○ |
| 13. Scientists follow the scientific method that always leads to correct answers | ○ | ○ | ○ | ○ |

- | | AGREE → | | | |
|---|----------|---|---|-------|
| | Disagree | | | Agree |
| 14. We should always trust what scientists have to say | ○ | ○ | ○ | ○ |
| 15. Scientists are neutral and objective | ○ | ○ | ○ | ○ |
| 16. Scientific theories develop and change all the time | ○ | ○ | ○ | ○ |

H. My out of School Experiences

How often have you done this outside School?

(Give your answer by shading the appropriate circle on each line.
If you do not understand the question, leave the line blank.)

- | | No. of TIMES → | | | |
|--|----------------|---|---|-------|
| | Never | | | Often |
| 1. Tried to find the star constellations in the sky | ○ | ○ | ○ | ○ |
| 2. Read my horoscope (telling future from the stars) | ○ | ○ | ○ | ○ |
| 3. Read a map to find my way | ○ | ○ | ○ | ○ |
| 4. Used a compass to find direction | ○ | ○ | ○ | ○ |
| 5. Collected different stones or shells | ○ | ○ | ○ | ○ |
| 6. Watched (not on TV) an animal being born | ○ | ○ | ○ | ○ |
| 7. Cared for animals on a farm | ○ | ○ | ○ | ○ |
| 8. Visited a zoo | ○ | ○ | ○ | ○ |
| 9. Visited a science centre or science museum | ○ | ○ | ○ | ○ |
| 10. Milked animals like cows, sheep or goats | ○ | ○ | ○ | ○ |
| 11. Made dairy products like yoghurt, butter, cheese or ghee | ○ | ○ | ○ | ○ |
| 12. Read about nature or science in books or magazines | ○ | ○ | ○ | ○ |
| 13. Watched nature programmes on TV or in cinema | ○ | ○ | ○ | ○ |
| 14. Collected edible berries, fruits, mushrooms or plants | ○ | ○ | ○ | ○ |
| 15. Participated in hunting | ○ | ○ | ○ | ○ |
| 16. Participated in fishing | ○ | ○ | ○ | ○ |

	No. of TIMES →			No. of TIMES →	
	Never	Often		Never	Often
17. Planted seeds and watched them grow	<input type="radio"/>				
18. Made compost of grass, leaves or garbage	<input type="radio"/>				
19. Made an instrument (like a flute or drum) from natural materials	<input type="radio"/>				
20. Knitted, weaved etc	<input type="radio"/>				
21. Put up a tent or shelter	<input type="radio"/>				
22. Made a fire from charcoal or wood	<input type="radio"/>				
23. Prepared food over a campfire, open fire or stove burner	<input type="radio"/>				
24. Sorted garbage for recycling or for appropriate disposal	<input type="radio"/>				
25. Cleaned and bandaged a wound	<input type="radio"/>				
26. Seen an X-ray of a part of my body	<input type="radio"/>				
27. Taken medicines to prevent or cure illness or infection	<input type="radio"/>				
28. Taken herbal medicines or had alternative treatments eg. acupuncture	<input type="radio"/>				
29. Been to hospital as a patient	<input type="radio"/>				
30. Used binoculars	<input type="radio"/>				
31. Used a camera	<input type="radio"/>				
32. Made a bow and arrow, slingshot, catapult or boomerang	<input type="radio"/>				
33. Used an air gun or rifle	<input type="radio"/>				
34. Used a water pump or siphon	<input type="radio"/>				
35. Made a model such as a toy plane or boat etc	<input type="radio"/>				
36. Used a science kit (like for chemistry, optics or electricity)	<input type="radio"/>				
37. Used a windmill, watermill, waterwheel etc	<input type="radio"/>				
38. Recorded on video, DVD or tape	<input type="radio"/>				
39. Changed or fixed electric bulbs or fuses	<input type="radio"/>				
	No. of TIMES →			No. of TIMES →	
	Never	Often		Never	Often
40. Connected an electric lead to a plug etc	<input type="radio"/>				
41. Used a stopwatch	<input type="radio"/>				
42. Measured the temperature with a thermometer	<input type="radio"/>				
43. Used a measuring ruler, tape or stick	<input type="radio"/>				
44. Used a mobile phone	<input type="radio"/>				
45. Sent or received an SMS (text message on a mobile phone)	<input type="radio"/>				
46. Searched the internet for information	<input type="radio"/>				
47. Played computer games	<input type="radio"/>				
48. Used a dictionary, encyclopaedia etc on a computer	<input type="radio"/>				
49. Downloaded music from the internet	<input type="radio"/>				
50. Sent or received e-mail	<input type="radio"/>				
51. Used a word processor on the computer	<input type="radio"/>				
52. Opened a device (e.g. radio, watch, computer etc) to find out how it works	<input type="radio"/>				
53. Baked bread, pastry, cake etc	<input type="radio"/>				
54. Cooked a meal	<input type="radio"/>				
55. Walked while balancing an object on my head	<input type="radio"/>				
56. Used a wheelbarrow	<input type="radio"/>				
57. Used a crowbar (jemmy)	<input type="radio"/>				
58. Used a rope and pulley for lifting heavy things	<input type="radio"/>				
59. Mended a bicycle tube	<input type="radio"/>				
60. Used tools like a saw, screwdriver or hammer	<input type="radio"/>				
61. Charged a car battery	<input type="radio"/>				
	No. of TIMES →			No. of TIMES →	
	Never	Often		Never	Often

I. Myself as a Scientist

Assume that you are grown up and work as a Scientist. You are free to do research that you find important and interesting. Write down some sentences about what you would like to do as a researcher and why.

I would like to...

Because...

J. How many books are in your home?

There are usually about 40 books per metre of shelving. Do not include magazines. (Please tick only one box.)

- | | |
|------------------------------------|---|
| <input type="radio"/> None | <input type="radio"/> 101-250 books |
| <input type="radio"/> 1-10 books | <input type="radio"/> 251-500 books |
| <input type="radio"/> 11-50 books | <input type="radio"/> More than 500 books |
| <input type="radio"/> 51-100 books | |

K. How I feel about Science in School

To what extent do you agree with the following :

(Give your answer by shading the appropriate circle on each line. If you do not understand the question, leave the line blank.)

- | | Disagree ← AGREE → Agree |
|--|---------------------------------|
| 1. In Science, I would rather learn a lot about fewer topics than a little about a lot of different topics | ○ ○ ○ ○ |
| 2. Doing practical and experimental work helps me to understand science topics | ○ ○ ○ ○ |
| 3. Doing practical and experimental work with good, modern apparatus makes me want to study Science | ○ ○ ○ ○ |
| 4. My School Science rooms are exciting places in which to work | ○ ○ ○ ○ |
| 5. If the practical content of the course were increased, it would give me a greater enjoyment of Science | ○ ○ ○ ○ |
| 6. I found Science at Primary School interesting | ○ ○ ○ ○ |
| 7. Science at Primary School prepared me well for Science classes in Secondary School | ○ ○ ○ ○ |
| 8. I find Science in Secondary School more interesting than Science in Primary School | ○ ○ ○ ○ |
| 9. What I learned in S1 and S2 Science, helped me with the Science course I now take | ○ ○ ○ ○ |

Disagree ← **AGREE** → Agree

Your Questionnaire is now complete.

Please return it now.

THANKYOU

