

Exploring young people's views on science education

September 2011

Exploring young people's views on science education

Report to the Wellcome Trust

September 2011

**Prepared for the Wellcome Trust by NFER,
the National Foundation for Educational Research
www.nfer.ac.uk**

Contents

Executive summary	4
Introduction	4
Views on and engagement with science	4
Influences on science education	5
Science in society and science careers	6
Science outside the classroom	7
Improving engagement with science education	7
1. Introduction	11
1.1 Background	11
1.2 Aim of the research	11
1.3 Research methods	12
1.4 About the young people	12
1.5 Structure of the report	13
2. Views on and engagement with science	14
2.1 Introduction	14
2.2 Young people's enjoyment of school and studying	14
2.3 Young people's favourite subjects at school	16
2.4 Young people's enjoyment of, and interest in, science at school	16
2.5 Young people's perceptions of the level of complexity of science education	19
2.6 Young people's perceptions of science compared with other subjects	22
3. Influences on science education	24
3.1 Introduction	25
3.2 Progression/ambitions	25
3.3 The learning context	26
3.4 Significant individuals	29
3.5 Personal perspectives/outlooks	30
4. Science in society and science careers	33
4.1 Introduction	33
4.2 The importance of learning science at school	34
4.3 The uses and applications of school science in everyday life	35
4.4 The value of science education for young people's futures	37
4.5 Attitudes towards undertaking further study in science and pursuing a science career	38
4.6 Young people's perspectives on the wider value of science education	39
5. Science outside the classroom	41
5.1 Introduction	42
5.2 Informal science opportunities presented through school	42
5.3 Informal science opportunities independent of school	44
6. Improving engagement with science education	49
6.1 Making science more relevant and applicable to everyday life	49
6.2 Promoting science as interesting and fun	50
6.3 Provision of improved advice on the benefits of science education for future progression pathways	51
6.4 Pedagogical approaches	51

References	53
Appendix 1: Out-of-education interviewees (characteristics)	56
Appendix 2: Research instruments	58
A2.1 Questions used in focus groups in schools	58
A2.2 Questions used in interviews with pupils in school	61
A2.3 Questions used in interviews with young people out of education	63

Executive summary

Introduction

- In early 2010, the Wellcome Trust published research which explored young people's (14–18 years) attitudes to school science education, including motivations and barriers to learning and general perceptions of careers in science (Butt *et al.*, 2010). The positive picture of experiences of learning science at school presented in this research is particularly welcome. Research from earlier this decade reported a decline in engagement with science, technology, engineering and mathematics (STEM) study and subsequent choices to pursue STEM-related careers (e.g. Roberts Review, 2002; Stagg *et al.*, 2003).
- In order to inform approaches to promoting learning in science better, there is a need for further, in-depth exploration of the factors, or drivers, that determine young people's interest in, and subsequent engagement with, science. It is in this context that the Wellcome Trust commissioned the current research, which aims to provide a deeper understanding of young people's attitudes to science education, particularly regarding the value young people place on science education (for themselves as individuals and for society in general), as well as the key factors determining their continued engagement with formal and informal science education.
- The study had three main strands of research activity:
 - a brief review of relevant UK literature over the past ten years
 - case studies in 20 schools involving interviews and focus groups with a total of 240 pupils
 - consultation with 20 young people aged 16 and above who have left education.
- In addition, teachers from eight of the 20 case-study schools agreed to participate in short telephone discussions with research staff to reflect upon and comment on the findings from the research, as well as any potential implications for science teaching. Their collated comments are included, where appropriate, throughout the main report and feature within this Executive Summary in the final section on improving engagement with science education.
- This report draws together the findings from each strand of the research.

Views on and engagement with science

- This research shows that the majority of pupils in the sample demonstrated considerable degrees of enjoyment of, and interest in, learning science at school. There is a strong view that science should continue to be taught up to compulsory school leaving age to empower young people and increase their general knowledge and understanding.
- There is an apparent correlation between general levels of engagement with school/learning and with enjoyment of studying science. The most critical views about science in this sample were expressed by those who were having, or who had had in the past, negative experiences of school. Conversely, those young people who demonstrated the greatest enthusiasm for science were generally those who attached the greatest value to education in general.

- Pupils in this sample did not generally proffer 'black-and-white' views on science relative to other subjects, but identified positives and negatives for all curriculum areas, illustrating that there is not a continuum of liked and disliked subjects. Similarly, within the sciences, opinions varied about the various merits and perceived difficulties or challenges associated with physics, chemistry and biology.
- Key elements underpinning pupils' engagement with science revolved around individuals' levels of personal interest in learning science, and perceptions of teachers' engagement, commitment and enthusiasm. Furthermore, hands-on practical activities, when seen to be relevant to and integrated into the theoretical element of lessons, were a particularly appealing element. Higher levels of pupil engagement in science also related to perceptions of its applicability and transferability to 'real-world' situations, including further study (at university level) and employment opportunities. Science was also held in high regard by some because of its perceived distinctive approach and the ability to find definitively 'correct' answers, as opposed to the discursive nature of essay-based subjects.
- Science was often regarded as a necessary part of young people's qualification portfolio, whether they wished to pursue a science-related career or not. Personal interest remained the key driver behind young people's decision to study science (in non-compulsory settings). It was suggested that capitalising on the 'fun' approach to primary school science could help to engage young people in science at secondary school.

Influences on science education

- This research confirms the value accorded to science education by young people during, and post, compulsory schooling. Science was regarded by many as an essential component in their portfolio of skills and qualifications, one that can help secure successful post-school progression in both science and non-science related destinations. Pupils suggested that success in science at school would enhance their chances of securing places at (more prestigious) universities. There is, however, a strong indication from young people in this study that such benefits are not always made clear enough to them.
- Young people in this study expressed a preference for more practical, hands-on activities, which they believed made learning science more interesting and subsequently easier to understand.
- Science was seen as being content heavy with more work involved than for other subjects. Equally, the assessment strategy used in science was felt to be particularly examination focused and set at a very high standard. Young people indicated that more continuous assessment and feedback would encourage engagement and subsequently learning.
- There was also a clear indication in the current research, that young people would be more engaged with science if it were more applicable and relevant to contemporary life.
- Young people in the current study identified the quality of the educational experience provided by the teacher as a factor influencing engagement with science education. The study also presents young people's views on what constitutes 'good' and 'poor' teaching:

- Teachers who acted as a positive influence on attitudes towards science were reported to be those who: made science lessons enjoyable, interesting and understandable through their passion for their subject, or by helping young people to access appropriate information and advice about further study or a career in a science-related field.
 - Conversely teachers who acted as a negative influence on attitudes were those who put students down; did not offer enough help or encouragement; expected students to just copy down notes; or had problems with discipline. This clearly underlines the importance of the supply and retention of well-qualified, experienced and motivated science teachers, supported by subject-specific and high-quality professional development.
- The current research clearly shows that young people would welcome a greater and earlier emphasis on careers guidance, and on the use/value of science at an earlier stage in their school life. Maintaining and capitalising on that early interest may be more challenging, given the constraints of an already overloaded curriculum.

Science in society and science careers

- Young people participating in this research generally supported the notion that learning science was valuable for both individuals and society. For individuals, the acquisition of scientific knowledge was seen to contribute to their own personal development in terms of supporting real-world awareness, and delivering specific substantive understandings.
- Pupils revealed overwhelming support for science education in school to be compulsory. This reflected the acknowledgement that the subject carried with it significant importance and value for scientists and non-scientists because of its universality of application.
- In addition, the current research also confirms that pupils, whilst agreeing that science education is important, have difficulties in making direct links and associations between what they learn at school, and how they apply this in everyday situations. Thus, this research has indicated that there may be scope for increasing pupils' understanding of how the science they learn at school can be of direct relevance and application in their everyday lives.
- Similarly, different areas of the science curriculum were seen to have varying degrees of use and relevance, with many students questioning the value of in-depth study of theoretical concepts in favour of more readily accessible topics and activities. In order to increase engagement with science education, perhaps further investigations of how to enhance this linkage and these perceptions would be valuable.
- Young people in the current study highlighted the relationships between the technical skills and knowledge gained through science education and future employment opportunities. The majority of young people thought that science-related careers could provide rewarding employment, although a relatively limited range of possible jobs was revealed. Those with less successful school careers were least likely to see the benefits and relevance of science education for securing employment, with maths and English been seen as the critical qualifications required by employers. Increased focus on career development and the role/value of science education earlier on could help to address this.

Science outside the classroom

- Young people's views in the current research clearly demonstrate the need for science activities outside the classroom environment (for example, school trips) to be integrated into the overall delivery of the curriculum to ensure that they act as enhancement and enrichment activities and not just enjoyable, but possibly distracting activities.
- Young people in this study emphasised the 'fun' and enjoyable aspects of activities outside the classroom. Given the fact that personal interest is a key driver in their decision to study post-compulsory science (see Chapter 2), providing more opportunities for experiences outside the classroom environment could be a useful way of encouraging student engagement in science education.
- It was also clear, however, that young people did not always recognise the opportunities to apply scientific principles afforded through, for example, a visit to a theme park (such as forces or gravity). Making the links clearer may go some way to ensuring the greater relevance of science education to everyday, contemporary life.
- Several young people in the current study reported watching factual science-related television programmes, although they did add the qualification that they might do so because nothing else was on, or because they did not realise it was a science programme. Young people were less likely to read newspapers to access science information, or to use the internet unless it was to support school work. Capitalising on the accessibility of television and the internet as a way of reaching young people and stimulating their interest in science could be a useful way forward.

Improving engagement with science education

- It is clear that many of the young people in the current study were enthusiastic about learning science, appreciating both its value and relevance to their lives, and possible future ambitions and opportunities. Those who were more engaged tended to be those who had greater levels of personal interest and ability in the subject. Equally, there were a number of factors that could either encourage or discourage young people from learning science including, for example, the learning context, significant individuals (e.g. parents, family members, teachers and friends) and personal perspectives or outlooks.
- Engagement with science education could be further improved in the future in a number of ways:
 - Making science more relevant and applicable to everyday life by **raising the profile of science education within the overall school curriculum**; and enhancing perceptions of its **relevance and applicability to everyday life**. There may be scope for exploring ways in which science can be better 'marketed' to young people, by focusing on the subject's image and potential relevance/usefulness to counter negative connotations. Scientific concepts could be better explored in such a way that their connection to the real world is enhanced. Young people sometimes felt that they were accumulating knowledge solely to pass an examination because that connection had not been made explicit. As a result, this could impact negatively on their engagement with science. However, in doing so, it is also necessary to ensure that the content and academic rigour of science education is not compromised. In addition, it was noted that it might be profitable to update some of the reference points used in

science education, to make better use of contemporary situations and contexts that may be more accessible and understandable to young people.

Teacher commentary:

Teachers confirmed the need to think of newer examples and applications to make science education appear more relevant to pupils. There was a feeling that the topic of sustainability and energy conservation, for example, could have reached saturation point, being taught from primary age and throughout secondary school science. New examples could be more geared to specific industries. The recent rise of scientists presenting high-profile, prime-time television shows about astronomy and other scientific content has helped some teachers change their reference points and provide examples and illustrations that pupils are more familiar with.

Teachers also suggested that the curriculum is still examination, target and policy-driven, so some suggested that the examination boards need to lend support to such an approach, otherwise teachers will be reluctant to deviate too far 'off topic'. It was noted that recent curriculum developments through, for example, the National Curriculum Review and the Curriculum for Excellence in Scotland, would help teachers to develop the curriculum and allow a modernisation of content and approach with an increased focus on active learning.

It was also contended that any developments in curriculum content or delivery need to be supported by appropriate staff development activities and investment – school staff need to be supported in learning about recent developments in science and methods of delivery.

- **Promoting science as interesting and fun** by capitalising on, and demonstrating, the potential for science to be interesting, fun and engaging so as to avoid potential negative perceptions of it as boring or difficult. There is a need to look for connections and build upon positive experiences of science education developed earlier on in young people's school careers. It was often noted that young people had enjoyed science at primary school because it appeared to be a fun and appealing subject. Hence, it is important to maintain and extend that early interest to encourage young people's engagement with the subject during and beyond the compulsory period. This could be done through enhancement and enrichment activities including more practical and group work, and opportunities for learning outside the classroom including, for example, competitions between schools with a scientific theme, which could be an effective way of increasing young people's interest, such as designing and building go-karts to race, or devising prototype solar energy systems for the school.

Teacher commentary:

There was agreement amongst teachers that more attention could be given to increasing the 'fun' elements of teaching and learning by focusing more on enrichment activities to help increase pupil engagement.

Barriers to this were reported to include: the already full curriculum, which imposes restrictions on the amount of time that could be devoted to practical activities, group work and learning outside the classroom activities; as well as the time required to devise and prepare meaningful and useful practical activities.

- **Provision of improved advice on the benefits of science education for future progression pathways.** Currently, young people felt they did not always have sufficient information to be able to make informed choices. Engagement with science education could be increased by developing the nature and extent of the advice provided (e.g. by extending their knowledge of the range of career and study opportunities available to them through studying science), and

delivering it at an earlier stage. In this way, science could be seen to be more meaningful and more directly useful for young people. Drawing on experts and practitioners working in science-related fields could be particularly beneficial.

Teacher commentary:

Teachers agreed that there are potential benefits in providing careers and subject area advice at an earlier age, certainly pre-options choices. Some suggested this could be introduced at primary school by attempting to embed the importance of science education at an early age.

Teachers supported the idea of inviting professionals and experts to engage with pupils, including academics from universities and other educational establishments and a range of professionals and practitioners representing variety of industries and occupations. The first-hand knowledge, experience and perspectives of these individuals could provide a valuable resource to help pupils realise the potential value of pursuing science education. Several teachers suggested that universities have a crucial role to play in this, given school staff's pressure in delivering the curriculum and achieving targets.

One teacher highlighted that subject teachers had the responsibility for raising the profile of specific subjects in terms of pupils' individual career choices and progression opportunities, aided by computer software.

- **Belonging to a STEM network** was also seen as a way of helping students engage with, and discover the value of, science education. It was also contended that employers in the science community needed to recognise that changes in the skill-set and abilities of potential new employees may be required (such as the increasing importance of vocational qualifications and practical abilities, rather than a focus on degree-level qualifications).
- **Pedagogical approaches.** Pupils were critical of the assessment strategy used in science, which was felt to be particularly examination focused. As well as the focus on assessment 'of' learning through summative testing, it may be that greater emphasis on the techniques of assessment 'for' learning (e.g. verbal and written feedback, peer and self-assessment etc.) would be beneficial. There was wide-ranging appreciation of, and support for increasing, the practical element of science lessons. This was felt to make the theoretical elements of the subject more accessible and understandable to young people. However, it was also seen as important to ensure that these practical activities were used as a purposeful part of an integrated teaching and learning approach rather than a standalone, 'fun' activity. Closely related to this, engagement may also be increased when young people are provided with opportunities for greater interaction and participation in the lesson, rather than being the passive recipients of knowledge. Suggestions included learning in a workshop/seminar-style environment facilitated by teachers, practical experiments using more up-to-date equipment, discussion and debate, as well as opportunities for learning outside the classroom environment. Clearly, young people appreciated teachers who can convey passion and enthusiasm for their subject.

Teacher commentary:

Teachers offered varied responses in relation to pupils' perspectives on testing. Nearly all these teachers contended that formal testing through examinations would remain the primary means of assessment and that science teaching had to remain focused on this. Peer assessment was recognised as a potentially useful tool to be explored.

Teachers contended that practicals have value, and serve to enrich pupils' experience of, and learning in, science, if and when they are appropriate and integrated into curriculum delivery. There is a risk that practicals may

distract pupils from learning if they are not properly devised and implemented. Interaction between teachers, pupils and the subject are still seen to be the key elements in effective teaching and learning approaches. There was teacher support for the idea of encouraging pupils to participate in lessons actively, through practical activities, group work and class discussions. Having enthusiastic staff with the ability to motivate and inspire pupils to engage with, and enjoy learning science was seen as the most effective means of encouraging and supporting pupils' learning.

- **Ensuring space and support** within an already pressurised curriculum to enable teachers to deliver in these more innovative and engaging ways.

Teacher commentary:

Reinforcing this, one teacher suggested that new approaches – such as seminar- and debate-style lessons – may make some teachers feel as though they were operating outside their 'comfort zone'. Hence, continuing professional development (CPD) opportunities for existing staff members, and enhanced initial teacher training (ITT) content, may facilitate and support this.

1. Introduction

This report presents the findings from a study funded by the Wellcome Trust exploring young people's views on the value of formal and informal science education, both for themselves and for society in general.

1.1 Background

A number of research studies conducted in the early 2000s reported a decline in engagement with science, technology, engineering and mathematics (STEM) study and subsequent choices to pursue STEM-related careers (e.g. Roberts Review, 2002; Stagg *et al.*, 2003). This was seen to be of particular concern given the importance of the science-based economy in the UK (HM DTI/DfES, 2004).

In response to this concern, the Science and Innovation Investment Framework 2004–2014, and subsequent 'Next Steps' document (HM DTI/DfES, 2006), set out the Government's ambitions to build a STEM education and training environment capable of delivering a strong supply of scientists, technologists, engineers and mathematicians. More recently, the STEM Programme Report (2006) and the Sainsbury Review of Science and Innovation (Sainsbury, 2007) paved the way for further developments of the STEM agenda. Since then, a range of interventions and programmes has been implemented in an attempt to address these issues.

In early 2010, the Wellcome Trust published research – The Wellcome Trust Monitor: tracking public views on medical research – that explored young people's (14–18 years) attitudes to school science education, including motivations and barriers to learning, and general perceptions of careers in science (Butt *et al.*, 2010). This research reported a significantly more positive picture of experiences of learning science at school, with respondents finding science lessons interesting, and often considering them to be more interesting than those in maths or English. The report also suggested that science is generally a popular subject among young people, considered to be valuable for both higher education and career opportunities.

The positive findings from the above report are particularly welcome given the concerns voiced in the earlier research quoted above. However, in order to better inform approaches to promoting learning in science, there is a need for further, in-depth exploration of the factors, or drivers, that determine young people's interest in, and subsequent engagement with, science. It is in this context that the Wellcome Trust commissioned the current research.

1.2 Aim of the research

The overall aim of the current study was to explore and understand better the attitudes to science education of young people aged between 14 and 18 years, with particular reference to:

- the value that young people place on science education for themselves as individuals and for society in general
- the key factors determining young people's continuing engagement with both formal and informal science education.

1.3 Research methods

The study involved three main strands of research activity:

- literature review
- school case studies of pupils in secondary education
- consultation with young people aged 16 and above who have left education.

In addition, on completion of the initial analysis, teachers in the case-study schools were invited to participate in short telephone discussions with research staff to reflect upon and comment on the findings from the research, as well as any potential implications for science teaching. Teachers in eight of the 20 case-study schools accepted this invitation. Collated comments from these discussions are included in text boxes, where appropriate, throughout the report.

1.3.1 Literature review

Parameters for the brief review of the literature were set between the Wellcome Trust and National Foundation for Educational Research (NFER). NFER's Library staff searched a range of education, social care and sociological databases for other research studies that have been undertaken over the past ten years within the UK with young people aged 14–18, and their parents and teachers, on the topic of the study. Initial searches resulted in 37 sources being selected as relevant to the literature review. Detailed examination of these sources led to the final inclusion in the review of 20 sources that were deemed to be the most pertinent to the themes under study.

1.3.2 School case studies

Visits were made to 20 schools in order to consult with pupils aged between 14 and 18 (Years 10 to 13 and S3 to S6 in Scotland). The selected schools included: comprehensive schools; community schools; grammar schools; academies and sixth-form colleges. Eleven of the schools were in England, three in Wales, three in Northern Ireland and three in Scotland. Pupils were consulted via face-to-face interviews and small focus groups (of between five and eight pupils). The focus groups included a mixture of verbal questions to the group as a whole and a number of questions that pupils answered individually via the Audience Response System (ARS). This system is designed to engage young people using *Who Wants to be a Millionaire?*-style keypads. (Responses elicited via the ARS system are displayed in graphical form throughout the text of this report.)

1.3.3 Consultation with young people aged 16 and above who have left education

To gather the views of young people aged 16 and above who had recently left education and were working, in training or unemployed, face-to-face or telephone interviews were conducted in a range of settings, including job centres and Connexions offices.

1.4 About the young people

An overall total of 240 pupils aged between 14 and 18 years were consulted within the 20 case-study schools. Twenty-two focus groups were conducted with 152 pupils. Eighteen of these focus groups were conducted with individual year groups (two with Year 9; six with Year 10; five with Year 11; two with Year 12; and three with Year 13), while four were conducted with mixed year groups (one with pupils from Years 7 to 12; one with pupils from Years 10 to 11; one with pupils from Years 10 to 13; and one with pupils from Years 12 to 13). In addition, 70 face-to-face interviews took place involving 88 pupils mainly from Years 10 to 13, 60 of which were conducted with individual pupils and nine

as group interviews with between two and four pupils. The sample included those pupils studying science as a compulsory subject, as well as a number who had chosen to take it as a post-compulsory subject, and a smaller number who had elected not to study science in the post-compulsory period.

Twenty young people who had recently left education and were working, in training or unemployed were involved in the out-of-education interviews. The out-of-education interviewees were accessed mainly via visits to Connexions Centres in two regions of England (West Yorkshire and Berkshire), where Connexions staff directed young people visiting the centre to the researcher for face-to-face interviews. Their ages ranged predominantly from 16 to 19, although two were older (20 and 22). Twelve of the young people were currently in training; seven were currently unemployed (two of whom were looking for appropriate training courses); and one was working (as a part-time model). More detailed information on the characteristics of these young people can be found in Appendix 1.

1.5 Structure of the report

This report draws together the findings from each strand of the research. Following this introduction to the study, the report is divided into seven subsequent chapters.

Chapter 2 explores the extent to which young people engage with school and with science at school.

Chapter 3 focuses on the factors that positively or negatively influence young people's engagement with science education.

Chapter 4 considers young people's perceptions of the value of science education, both for them personally and for society in general. It looks at the relevance of science in everyday life and for society, as well as the value of science for life and careers.

Chapter 5 explores young people's engagement with informal science education. It considers the informal opportunities that exist in school, but also those that young people engage with independent of school.

Chapter 6 concludes the report by presenting recommendations, based on the suggestions put forward by young people themselves, as to how young people's engagement with science education might be improved.

2. Views on and engagement with science

What does the literature say?

- Previous research has raised concern about the low numbers of pupils choosing to take non-compulsory science subjects (for example, Cleaves, 2005; Smithers and Robinson, 2008; Bennett, 2008). The Wellcome Trust Monitor (Butt *et al.*, 2010) found that just over four in ten young people in its sample were currently studying, or were intending to study, a science subject at A level (or equivalent).
- The Wellcome Trust Monitor (Butt *et al.*, 2010) strongly demonstrated that young people are interested in, and engaged with, school science. The Monitor showed that over half of all young people surveyed thought that science was more interesting than English and maths, and the majority found science lessons interesting. Just under a third of the Year 9 students in Bennett's (2008) three-year study reported that science was amongst their favourite subjects.
- However, the Wellcome Trust Monitor (Butt *et al.*, 2010) also reported that around 40 per cent of young people are put off learning science because they find the subject difficult or boring. This was echoed in other research by Oversby (2005) and Williams *et al.* (2003) who noted that half the students answering their questionnaire found physics either 'boring' or 'very boring'. Furthermore, Williams *et al.* (2003) found there was a link between finding a subject boring and perceptions of it as difficult.
- The majority of 14-18 year olds in the Wellcome Trust Monitor (Butt *et al.*, 2010) thought science was more interesting at secondary school than in primary school, which contrasts with the commentary from the Teaching and Learning Research Programme (2006) and studies by Barmby *et al.* (2008) and Reiss (2004) which found that positive attitudes towards science in Year 7 declined as pupils progressed through secondary school.
- Reasons cited in the literature for young people's interest in, and enjoyment of, science include: the opportunity to engage in practical activities; curriculum content (in terms of particular topics studied); relevance to everyday life; and the quality of teaching approaches (Reiss, 2000; Osborne and Collins, 2000; Williams *et al.*, 2003; Barmby *et al.*, 2008).

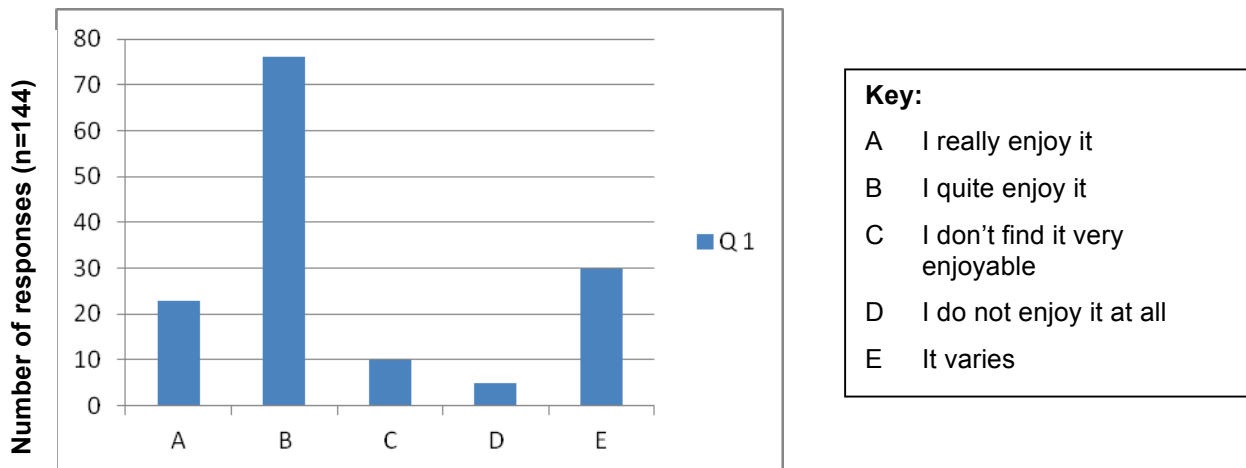
2.1 Introduction

This chapter explores the extent to which young people were engaged with school and science education in school. It looks first of all at how much they enjoy studying and their favourite subjects, then moves on to look at science more specifically, in terms of their enjoyment and perceptions of difficulty of the subject, as well as how science compares with their favourite subjects at school.

2.2 Young people's enjoyment of school and studying

Interviewees and focus group participants detailed a range of responses regarding their levels of engagement with school and the extent to which they enjoyed studying and learning. Whilst there was some variation amongst the sample as a whole, the majority of young people indicated that they were engaged in, and derived enjoyment from, studying whilst at school, as indicated in Figure 1.

Figure 1: Focus group participants' responses to the question: 'Overall, how much do you enjoy studying at school?'



Generally, young people enjoyed school and learning in terms of: opportunities for social life; studying; discovering new knowledge and information; and deriving fun and enjoyment from learning. In addition, levels of enjoyment and engagement (which were often closely inter-related) were variously influenced by the following factors:

- lesson type and content, including the nature and quantity of practical activities
- teacher characteristics
- teaching approaches/styles/presentation
- opportunities for participation and interaction in lessons/learning activities
- opportunities to learn new things
- the nature and quality of facilities and resources available in the learning environments.

I love studying – I think it's brilliant. It's fun, I enjoy doing the subjects. I enjoy the school environment. It is a good place to learn and grow up. I like school.

Year 10 interviewee

It might sound weird, but I like learning new stuff, specially in science. I enjoy it because it keeps you busy and you always have something new to research and find out about.

Year 10 interviewee

Some young people also identified challenges to their enjoyment of school and barriers to their learning. These included:

- disengagement and low levels of personal interest in school and learning
- perceived low levels of teacher quality/engagement.

I never studied. I just went to be with my mates, which I regret, because if I'd got my grades, I could be further on with my life.

Out-of-education interviewee, 17

A couple of lessons are not so good. I'm not keen on one of the teachers in biology. He's only turned up to one lesson out of six. We get set work and we go do it in the canteen.

Year 12 interviewee

Several students attending sixth-form colleges highlighted differences in the teaching and learning styles between school and college. There was a view that college could present a more adult environment where the tutors treated students in a more adult manner. In addition, it was suggested that college students were more engaged in learning as they had chosen to attend, so making the environment more conducive to effective learning. Many interviewees from the out-of-education cohort spoke of the difficulties of learning in environments where there was considerable disengagement. It was suggested that poor discipline and unruly behaviour from pupils presented significant barriers to learning.

2.3 Young people's favourite subjects at school

Across the sample, young people nominated a wide range of subjects as being their favourite. It was not possible to rank these as some young people offered more than one, others noted that whether or not a subject was a favourite could vary according to what they were doing in the subject at the time, and some young people could not nominate a favourite at all. Those subjects nominated as favourites included, for example, science or individual sciences (biology, chemistry, physics), history, geography, maths, drama, art, PE, French, food technology, economics, product design, music, English, catering and engineering.

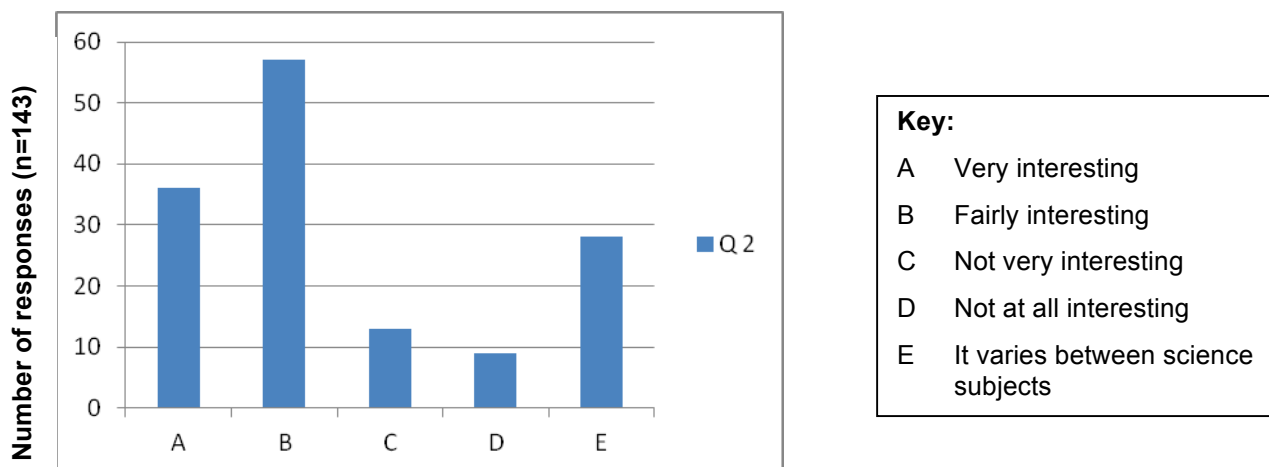
Reasons for particular subjects being identified as a favourite included:

- ease of learning/engagement with the subject
- having a prior interest in the subject, such as having studied it previously or parental/family interest in the subject through occupation, for example
- teacher characteristics and teaching style (e.g. perceived as being friendly, helpful and making learning interesting and fun)
- the nature of the learning/classroom activity, such as opportunities for practical/hands-on activity (e.g. science, PE, food technology, music, woodwork, business studies); opportunities for creative input (e.g. textiles, music, art); and opportunities to study beyond the classroom environment (e.g. PE, public services)
- finding the subject relevant to their everyday life or a future career.

2.4 Young people's enjoyment of, and interest in, science at school

The majority of young people stated that they enjoyed studying science, or certain elements of it, as highlighted in the responses of focus group participants shown in Figure 2 below.

Figure 2: Focus group participants' responses to the question: 'Overall, how interesting do you find science lessons at school?'



The fundamental elements underpinning young people's enjoyment of, and interest in, studying science were:

- the practical nature of lessons
- connections with the substantive content of science education
- the practical application and relevance of the subject
- perceptions of the ease of learning and the accessibility of science
- teacher quality and approaches.

Teacher commentary:

Teachers broadly agreed with the level of interest and engagement in science highlighted by pupils, although one expressed 'pleasant' surprise, suggesting that science may have declined in popularity in recent years as pupils began to favour more 'trendy' subjects, such as media studies. Teachers generally contended that science could be particularly engaging for the highest achieving pupils and those with the highest levels of personal interest. Practical activities were identified as significant elements in science's appeal to a broad range of pupils.

There was general agreement that practicals and experiments make science more enjoyable and more fun. Particular value was to be gained when students are actively involved in these activities rather than watching demonstrations by the teacher (seen to be necessitated by a lack of resources and facilities). Practical work was felt to be beneficial as it helped students remember facts and information, made the scientific theory and principles behind the activity easier to comprehend, and brought learning to life. Practical classes also helped to demonstrate the real-world application of scientific knowledge.

I like chemistry because you can do a load of practicals and you get to mix different chemicals together and see what happens. You don't do practicals in other subjects, like maths – it's boring because you just sit there.

Year 10 focus group participant

Practical classes were valued equally across the spectrum of academic ability, although many of those from the out-of-education cohort who had left school with few academic qualifications remembered being particularly engaged by undertaking experiments.

I think I did combined science, but can't remember anything about it. I didn't really take to it. I didn't find it interesting – it didn't catch my eye. I did try, but I just couldn't get on with it. When you did practicals, I enjoyed it, but I just didn't take any notice of the theory.

Out-of-education interviewee, 17

We did all of the sciences. It was good because I don't think we went one lesson without getting up and doing something. Experiments and that. I liked chemistry – I think it was the most interesting. Instead of writing out of the book, the teacher explained it better.

Out-of-education interviewee, 17

Despite the general positive orientations, some young people were less engaged in, and enthused by, practical activities, suggesting that no additional knowledge is gained above that derived from reading textbooks or computer-based research. This was especially the case when there was a perceived lack of clarity about the purpose of the activities and how they related to the rest of the science curriculum: 'You just do them and learn nothing. If you did the theory first and then did a practical on that it would help' (Year 10 interviewee).

Teacher commentary:

Teachers unanimously agreed that pupils derived high levels of enjoyment and sense of achievement from being actively involved in hands-on, practical activities in the classroom. Practical activities were described as being the 'highlight of science' for some pupils, although there was agreement that these activities needed to be well integrated into the overall delivery of the curriculum and not to exist as a distraction from theoretical work.

Some young people commented that they enjoyed science because they found it interesting in terms of the substantive content, such as the connection between biology and personal interest in animals. Others found the problem-solving elements of chemistry, for example, to be particularly appealing. Interestingly, pupils from most of the case-study schools highlighted the presence of definite answers in science subjects, as opposed to the discursive and interpretative nature of arts and humanities subjects, to underpin their attractiveness. It might be profitable to consider promoting this distinctive element of science education to increase its appeal to young people.

I like the way of learning, especially in chemistry, and I like the way there are definitive answers which are not open to interpretation like the essay-based subjects.

Year 13 interviewee

Enjoyment of science also stemmed from its perceived relevance to 'real life' and young people's personal interest in it. Young people referred to discovering scientific knowledge relating to the world around them; information about the mechanics of the human body; developments in medical technology; and forensic science. In addition, enjoyment of science stemmed from connections with, and relevance for, other school subjects or areas of interest, including sports sciences and nutrition, and astronomy.

There was also variance in relation to views of the individual science subjects. Young people presented different perspectives on the three main areas of science, whereby biology, chemistry and physics attracted varying levels of support/inspired varying levels of enjoyment. There appears to be no clear pattern to this and no one particular element

of science was presented as more, or less, enjoyable than the others across the whole sample of young people. Furthermore, the constituent elements of each subject were also enjoyed to varying extents.

[Enjoyment] depends on which subject but also within subjects, so the topic you are doing. For example, studying the body is more interesting than doing about plants.

Year 11 interviewee

Many young people commented on the teacher influencing their enjoyment, commenting that if the teacher was good and explained things well, it was more enjoyable. Several young people did not enjoy science because the teacher did not make learning fun, or there was a lack of discipline – often partly due to very big class sizes. Those from the out-of-education cohort were particularly, but not exclusively, likely to express such a view.

In addition to these elements, a range of factors believed to challenge young people's enjoyment of science was revealed. These included:

- lack of connection with the subject matter, including finding it boring and having no personal interest in it
- complexity and levels of understanding whereby the subjects were seen to be too difficult, including the need to memorise and apply complex formulas
- connections between some science subjects (particularly chemistry) and maths was seen to be particularly difficult, so those who felt they were less proficient in maths suggested they also struggled in science
- inaccessible, uninteresting and dull teaching styles. Some students suggested that, other than practical activities, their enjoyment of science was limited by the high volume of writing involved.

2.5 Young people's perceptions of the level of complexity of science education

There was not a majority view or consensus across the sample as to the degree of complexity of science education, with young people revealing a range of views. The key factors influencing these opinions centred on:

- perceptions of the teacher/teaching approach
- perceptions of the subject content
- links/associations with other subject areas
- level of personal interest in the subject.

The greatest influence on whether young people found science easy or difficult centred on perceptions of the style and quality of teaching. A 'bad' teacher could make the subject more difficult. For example, '...if the teacher just expects you to copy things down, doesn't explain things and just sits at their computer then that makes it more difficult' (Year 10 interviewee).

It was quite difficult, because they just stood and talked and it was dull. The practicals were more enjoyable and made it easier to learn.

Out-of-education interview, 17

I found it a bit difficult because of the supply teacher that we had. It's quite a hard subject to learn with all the big words and stuff. I found it a lot easier when we had a proper teacher.

Out-of-education interviewee, 20

By way of contrast, 'good' teachers are able to explain things in a way that makes sense by making the lesson content interesting, 'fun' and interactive with good use of practical activities.

Science was my easiest subject. It was a specialist science college so they were good at teaching it. The teacher put more effort into the science lesson. The other teachers just didn't seem to want you there. There were more practicals in science.

Out-of-education interview, 17

The use of coursework and themed or topic-based work was particularly valued by some students. Science studies within a real-life context, for example the application of forensic science and 'CSI-type' projects, were said to help students effectively engage with science lessons.

I did applied science – like food science and forensic science. We didn't do the bog standard subjects like biology and chemistry. This was much more interesting because it puts it into more relevance for everyday life. It was taught differently as well. It was more coursework based. You know you have to do the work so you get on with it.

Year 12 interviewee

Forensic science work – it was really good. I got a B in this coursework but then I got a D in the exam. That's the difference. They set up a crime scene and we had to go out and take pictures and do fingerprints. It made it much easier to learn than just being sat at a desk because you're bored and it's easy to get distracted. It was fun and it made you want to learn more. It's harder to learn if you don't want to learn. This made you want to learn so you got a lot more out of it.

Out-of-education interviewee, 16

Hence, there was a strong correlation between enjoyment, engagement and the extent to which young people found learning science easy. Practical work appears to be a central element of this, whereby the individual and group work entails young people gaining hands-on experience and necessitates them discovering things for themselves, and learning within a real-life context. There may be scope for exploring ways in which science can be promoted and 'marketed' to young people by focusing on the subject's image, application and potential relevance and usefulness to combat possible negative perceptions of science being boring and difficult.

The extent to which a subject was perceived to be easy or difficult also related to perceptions of the subject content. Biology, for example, was sometimes thought to be relatively easier than other science subjects as it is 'just about remembering facts'. Conversely, theoretical chemistry is associated with formulas and, as such, could be seen to be more difficult. Personal perceptions thus played a significant role in defining individuals' thoughts on science subjects and there were also variations within individual substantive areas.

Chemistry is quite a difficult subject. Some areas are not too bad but then there are the darker areas that are quite difficult, like atomic structure, for me, is quite a no-go area. Not a lot could make it easier. But, a lot of atomic stuff is taught on the whiteboard and I think if it was more practical, it might be easier. Other areas are less interesting than others, and I don't really like them.

Year 10 interviewee

Links and associations between science and other subject areas also impacted on perceptions of its relative difficulty. Physics and chemistry, for example, were said by some to be closely linked with maths, so proficiency in maths supports learning in these areas: 'Physics is not too bad – maths helps with physics a lot' (Year 11 focus group participant); 'Chemistry is easier if you are good at maths' (Year 11 interviewee). Increased cross-curricular linkages between complementary subjects could be a means of enhancing young people's connection with science.

It was suggested that science was easier to learn when there was a greater level of affinity with the subject, indicating a correlation between interest and engagement and the extent to which science was found to be easy to learn: 'I find biology the easiest, probably because I enjoy it the most' (Year 12 focus group participant); 'Biology is the easiest because it is more interesting' (Year 10 focus group participant).

Teacher commentary:

Teachers commented that science was a difficult subject and efforts were being made to deliver the curriculum in ways which helped to make it more accessible and engaging for all students, especially those more at risk of disengagement. Several suggested that teachers had a critical role in fostering positive relationships between pupils and subjects. Practical activities and developing cross-curricular linkages were identified as potentially effective elements.

Many of the out-of-education cohort were unable to comment on the relative ease or difficulty of science, as a result of their general disengagement from school and learning as a whole, compounded by often challenging learning contexts.

Experiments were good fun but I didn't like the classrooms where we had to do science, sitting on them uncomfortable stools, it wasn't easy to learn. People was poking you and prodding you all the time when the teacher wasn't watching, so it was impossible to learn anything.

Out-of-education interviewee, 18

2.6 Young people's perceptions of science compared with other subjects

Young people revealed a range of views about science compared with other subjects. For some, science compared favourably with other subjects, whereas a number of young people preferred non-science subjects. Generally, there were positive feelings towards science subjects, even amongst those who did not class themselves as 'scientists' at school. The least attachment to science was exhibited by some young people from the out-of-education cohort.

Reasons for preferring science to other subjects largely echoed and built on previous findings in this chapter, focusing on two central themes:

- teaching styles and content, including teacher approaches

- perceptions of the relative importance or functionality and future applications of science compared with other subjects.

As previously noted, young people valued opportunities to engage in practical, hands-on and interactive elements of science lessons. Such approaches were deemed to make lessons more fun and so more likely to encourage pupils' participation and foster increased connections with these subjects. These teaching and learning styles were mainly associated with science classes, although it was suggested that similar activities taking place in other areas, such as geography, were also appreciated. Science lessons were also valued because of opportunities for group work in which pupils could engage in tasks that required them to work together to find things out for themselves. This active participation in learning was seen to be more effective than some, more passive, learning styles in other subjects where copying from textbooks or whiteboards was a predominant activity: 'In science, learning is more fun than other subjects and it's also more about finding out things for yourself' (Year 10 interviewee).

Young people highlighted differences in the nature of learning associated with science as opposed to other subjects. The central element to this stemmed from perceptions that science could offer different, and perhaps, greater intellectual challenges than arts and humanities subjects. The ability to find 'definite answers' in science also made it more appealing, to some, than the discursive approach of essay-based subjects. Such interpretations stemmed from individuals' personal perspectives and preferences: 'In chemistry, you can be sure that there is a definite answer. It's not as ambiguous' (Year 12 interviewee).

Teacher commentary:

Teachers revealed divided opinions about science being popular because of the presence of 'definitive' right or wrong answers. Teachers who agreed with this contended that pupils enjoyed the direct feedback from tests, which acted as barometers of their learning/progress in the subject. Those disagreeing with this suggested that if science was presented and understood as being the polemic of right/wrong, or black and white, then the subject was not being taught appropriately. Science was seen, by these teachers, as involving constantly evolving discovery of knowledge.

Science also compared favourably with other subjects because of perceptions of the relevance of its content for everyday life and future applications.

English and maths are just about passing exams whereas in science you actually learn things that are relevant to real life.

Year 11 interviewee

Key points from the research

- This research has shown that the majority of pupils in the sample demonstrated considerable degrees of enjoyment of, and interest in, learning science at school. There is a strong view that science should continue to be taught up to compulsory school leaving age to empower young people and increase their general knowledge and understandings.
- There is an apparent correlation between general levels of engagement with school/learning and with enjoyment of studying science. The most critical views about science in this sample, were expressed by those who were having, or who in

the past had had negative experiences of school. Conversely, those young people who demonstrated the greatest enthusiasm for science were generally those who attached the greatest value to education in general.

- Additionally, pupils in this sample did not generally proffer 'black-and-white' views on science relative to other subjects, but identified positives and negatives for all curriculum areas, illustrating that there is not a continuum of liked and disliked subjects. Similarly, within the sciences, opinions varied about the various merits and perceived difficulties or challenges associated with physics, chemistry and biology.
- Key elements underpinning pupils' engagement with science revolved around individuals' levels of personal interest in learning science, and perceptions of teachers' engagement, commitment and enthusiasm. Furthermore, hands-on practical activities, when seen to be relevant to, and integrated into, the theoretical element of lessons, were a particularly appealing element. Higher levels of pupil engagement in science also related to perceptions of its applicability and transferability to 'real-world' situation, including further study (at university level) and employment opportunities. Science was also held in high regard by some because of its perceived distinctive approach and the ability to find definitively 'correct' answers, as opposed to the discursive nature of essay-based subjects.
- Science was often regarded as a necessary part of young people's qualification portfolio, whether they wished to pursue a science-related career or not. Personal interest remained the key driver behind young people's decision to study science (in non-compulsory settings). It was suggested that capitalising on the 'fun' approach to primary school science could help to engage young people in science at secondary school.

3. Influences on science education

What does the literature say?

- A number of factors that influence young people's engagement with science education have been highlighted in the literature.
- Several sources have identified the quality of the educational experience provided by the teacher as a key factor determining engagement (Osborne *et al.*, 2003; Bennett and Hogarth, 2005; Teaching and Learning Research Programme, 2006; Springate *et al.*, 2008; Butt *et al.*, 2010). The Wellcome Trust Monitor (Butt *et al.*, 2010) found that just over half the young people in its survey said having a 'good' teacher encouraged them to learn science, while just under half reported being 'put off' by a 'bad' teacher (p.149–151). However, the study was not able to identify what constituted 'bad' teaching.
- The Teaching and Learning Research Programme (2006) noted that 'a shortage of well-qualified science teachers capable of providing a positive experience' may be influential in pupils' attitudes toward school science (p.6). At the same time, it identified the fact that many science teachers are required to teach sciences outside their own specialism, which can undermine their confidence and negatively affect the teaching and learning experience they provide. The report re-emphasised the importance of good specialist and enthusiastic teachers highlighted in earlier research by Osborne and Collins (2001) and Murray and Reiss (2005).
- The science curriculum was generally thought to be content heavy with too much repetition (Osborne and Collins, 2000; 2001), as well as including too much written work (Owen *et al.*, 2008), factors which many young people were said to find off-putting. There was much evidence within the literature of the preference of young people for more practical, hands-on and interactive activities and the potential of this type of activity for encouraging engagement with science education (Osborne and Collins, 2000; Cleaves, 2005; Murray and Reiss, 2005; DeWit and Osborne, 2008; Owen *et al.*, 2008; Butt *et al.*, 2010).
- Another factor influencing pupil engagement in science education was identified as the positive effect this could have on a young person's university and/or career ambitions (Osborne and Collins, 2000; Cleaves, 2005; Jenkins and Nelson, 2005; Bennett, 2006; Butt *et al.*, 2010). Springate *et al.* (2008) noted that a minority of the students in their study had decided to go on to study science subjects at university because of an awareness that these subjects would equip them with skills that were valued by employers. Bennett (2006) found 'considerable' evidence that ideas of future career directions (including science careers) begin to take shape in the early years of secondary school.
- Some young people were said to be influenced by parents who placed a higher value on maths or science subjects (Cleaves, 2005). Nearly all young people in the Wellcome Trust Monitor thought that it was important for their parents that they do well in science at school (Butt *et al.*, 2010). The study also found an overlap between parents' interest/engagement with science and the young person's level of interest.
- Four in ten of the young people involved in the Wellcome Trust Monitor were reported to have been put off learning science because they found it boring. Young

women in particular were said to be put off because they found the subject difficult. Those who were not planning to continue with post-compulsory science were especially likely to identify finding science boring or difficult as a factor discouraging their engagement with the subject (Butt *et al.*, 2010). Enjoyment of the science subject (often linked to ability) was found to be one of the most important influences on engagement across all the ethnic groups in Springate *et al.*'s (2008) study.

3.1 Introduction

This chapter looks at the factors that influence young people's engagement with science education. Firstly, it identifies the various factors and then seeks to explore how, and why, those factors have either encouraged, or discouraged, young people from learning science.

The research found that a wide range of factors influence young people's engagement with science education, a number of which reflects those found in previous research (see, for example, Murray and Reiss, 2005; Cleaves, 2005; Morris, 2006; Springate *et al.*, 2008; Butt *et al.*, 2010). These factors have been grouped as follows:

- progression/ambitions: benefit for future study or career paths
- the learning context: curriculum content and relevance, assessment, and availability/access
- significant individuals: parents/family, teachers and friends
- personal perspectives/outlooks (intrinsic to the individual): enjoyment or interest, perceived difficulty/ability and images of science.

3.2 Progression/ambitions

Both school-aged young people and those who had left education identified the benefit of science for future plans or ambitions as the most influential factor affecting engagement in science education. For the majority of young people identifying this as an influential factor, science was seen as a prerequisite for the future university course or career that they had already decided they wanted to pursue. For example, young people who had decided on a career path such as medicine, dentistry, veterinary science, sports science, engineering, or conservation, voiced an awareness of needing to study separate sciences at GCSE, A level and, for some, degree: 'My options were decided by wanting to go into medicine' (Year 12 focus group participant).

Other young people who had not yet decided on a future career, or did not think they wanted to pursue a science-related career, still recognised the value of studying science for accessing university, as it was seen as a 'good' subject to have in terms of grade entry. Similarly, science was seen as 'opening doors' to a wider range of career options – it was felt to develop a number of transferable skills (e.g. problem-solving), and to look good on a CV, as well as providing opportunities for increased earning potential: 'Science gets you far in life' (Year 7 interviewee).

There are hundreds of jobs out there for science degrees, whereas if you confine yourself to drama you can only really become a theatre practitioner or a movie star.

Year 12 interviewee

Teacher commentary:

Teachers agreed that success in science can open doors for pupils at all levels so that science qualifications can help students access the most competitive university courses and provide advantages in the labour market. There was a view that pupils perceived science to be a difficult subject, but worthwhile because of the associated kudos and value.

Interestingly, some young people, and particularly those who had left education, commented that the benefits of taking science for future study and career paths were not made clear enough by school staff.

At the time I didn't really think science would be useful but it does come in handy now – it's one of the main things you need. The teacher said you needed science but didn't say what for...No one really said anything about why science would be useful...If I'd been given a list of job roles that science is needed for, then there may have been something that would have appealed and I would have thought it might have been a useful thing to do.

Out-of-education interviewee, 18

This emphasises the importance of a continued, and perhaps earlier, focus on the provision of advice about university and career choices, particularly highlighting the links between specific science subjects and certain careers.

Teacher commentary:

There was a general consensus from teachers that more could be done to help promote science education and its potential benefits in terms of preparing pupils for positive progression to A level, university and employment. It was contended that efforts were already being made – such as visual promotion of science careers – although there was a feeling that the priority of careers education (in science and other subject areas) was diminished by a crowded curriculum and examination pressures. Embedding careers education in all subject areas was seen as a potential way of increasing pupils' awareness of the possible future benefits and implications of studying particular subjects.

3.3 The learning context

The next most influential factor affecting engagement in science education was the quality of the learning context, in particular, the content and relevance of the science curriculum, assessment strategies and the availability of, or access to, science courses of study.

Science was seen as being 'content heavy' (Year 13 interviewee), with more work involved than for other subjects, which tended to discourage some young people: 'It's just the theory and learning, it was so much' (Year 13 interviewee). A number of pupils in the case-study schools commented that they had been concerned that they would find the amount of work difficult to manage but, in fact, it had not been as problematic as they had feared. The way in which the different science lessons were split up across the week, intermingled with other subjects, had helped in this respect, '...it doesn't feel like you are doing as much science' (Year 10 interviewee). This suggests there may be some misconceptions about the curriculum and its delivery that would benefit from earlier clarification. This, in turn, might encourage more young people to take up science subjects.

There was some variability in young people's views concerning the emphasis within science on learning hard facts. This was viewed as off-putting by some Year 11 interviewees who preferred the more 'fluid' and 'malleable' nature of subjects such as English and RE, which could be shaped by pupils' own perceptions. Others, however, preferred the fact that there was usually a right or a wrong answer in science.

...with science and maths there's definitely a right answer. In a history essay, you can argue either way. I like it when there is just one definite answer – right or wrong.

Year 11 interviewee

Engagement levels could vary across science subjects, but also within, according to the topic being studied. For example, a number of pupils disliked the topics on plants in biology, preferring to learn about animal or human biology.

There was a strong feeling that there was too much written work involved in studying science, which was discouraging for many. Young people expressed a preference for more interactive and practical work, for example, experiments, presentations, debate and group work. This, it was believed, made learning about science more fun and exciting, more interesting, and subsequently easier. Reasons for a lack of practical work suggested by young people included the poor behaviour exhibited by some pupils when conducting experiments, shortage of time (given the amount of work to get through) and a lack of suitable equipment. Pupils in one of the case-study schools suggested that they would respect the equipment and resources more if they were of a better quality or more up to date.

Teacher commentary:

Practicals were seen as valuable in terms of their ability to motivate and engage pupils; to encourage pupils' independent learning; and to develop and enhance pupils' learning skills. Teachers also noted that time and curriculum pressures, as well as the difficulties of funding and technical support, acted as challenges to devising and implementing practical activities in class.

There was agreement on the **relevance** of science to everyday life; it was described by one Year 12 pupil as 'the core of the world'. Science was seen as a way of understanding the world and how things work. For example, one Year 13 interviewee explained how he had once believed that electricity travelled one way, but then had found out that, in fact, it travels the other way.

Seeing something in front of you and learning to understand something that you see on a daily basis...when someone shows you something and explains how it works – that's quite cool.

Year 12 interviewee

Young people also appreciated the fact that there was always something new to find out in science: 'Humans won't ever find all the answers, but we will try!' (Year 13 interviewee). However, in spite of this recognition of the relevance of science, there was a feeling amongst some young people that the applicability of certain topics to real life was not always made clear in their delivery: '[Some] things don't relate to real life at all – it's pointless. You only really need to know it for the test and then you forget' (Year 10 interviewee). Young people felt that making science more applicable to everyday life, by placing it in real-life contexts and showing how it relates to different careers or jobs, would encourage a greater number of young people to study science: 'There's more to it

than just being a subject – it's related to so many things' (out-of-education interviewee, 18).

Comments were made about the **assessment strategy** used in science, which was felt to be particularly examination focused, as well as being set at a very high standard. The pace required to keep on top of the work was felt to be intense. The pressure and fear of failing induced by this was believed to discourage some pupils from studying triple award science or progressing on to A level: 'The exams are a killer – you have to present the information in a certain way, and all of the information that is needed' (Year 12 interviewee).

All the exams – we get more in science than other subjects. We have to sit 21 exams over two years, you just think 'I'm never going to get through all this'. You've got to revise and revise.

Year 10 interviewee

I did AS biology last year and have now changed to something completely different and that's just down to the exam...I just didn't like the way it was done, it made me give up the subject. If the exam had been more straightforward – not easier, just easier to understand what it was they wanted, I would have carried on with the subject.

Year 12 focus group participant

Teacher commentary:

Teachers were divided in their perspectives on the extent to which science teaching was examination driven, some suggesting that qualification pressures dictated teaching approaches, whilst others suggested that rational and logical enquiry was inherent in the subject.

There was a feeling amongst pupils that an assessment strategy that included more continuous assessment and feedback would encourage learning, as opposed to focusing on improving performance: 'In combined science they have 100 per cent coursework, and for triple science we have 21 exams – half and half would be better' (Year 10 interviewee).

Exams only display ability at a certain time period. Getting As all the way through and then getting a B in one exam is not a true indication of your ability. The standard is extremely high.

Year 11 interviewee

It may be that, in addition to the focus on assessment 'of' learning through summative testing, a greater emphasis on the techniques of assessment 'for' learning (e.g. verbal and written feedback, peer and self-assessment, personal learning goals etc.) could be beneficial in improving engagement with science (and ultimately teaching and learning). This might help to avoid the danger of initial interest becoming overshadowed by perceptions of the pressures related to ongoing testing.

For some young people, **availability** or **access** had proved to be a factor influencing engagement with science education. For example, one Year 13 pupil referred to a friend who had been unable to take biology because he could not fit it into the school timetable along with the other subjects he wanted to study. In another case-study school, two Year 11 pupils had been told that the triple science course was full. One of these pupils, who wanted to be a vet, had been told she was 'borderline' and reported that she had

managed to secure a place on the course 'by fighting for it'. In two of the case-study schools, girls referred to being very much in the minority in science classes (e.g. five in a class of 20), which was sometimes difficult and could, they felt, discourage some girls from learning science:

It can be difficult, the lads have their own sense of humour – shouting at you when you're trying to concentrate – but it's generally OK.

Year 10 interviewee

3.4 Significant individuals

There were a number of significant individuals who were found to influence young people's engagement with science education, namely parents or other family members, teachers and friends.

A large number of young people who referred to being influenced by significant individuals identified their **parents or other family members** as being instrumental in encouraging them to study science. In several cases, young people's parents worked in a science-related field such as medicine, teaching or environmental science, or had studied science themselves and had an interest in the subject: 'My family is basically a sciencey family' (Year 13 interviewee). The link between parental interest and young people's willingness to engage in science education was also highlighted in the Wellcome Trust Monitor (Butt *et al.*, 2010). Young people in the current research reported that their parents tended to regard science as a useful and well-respected subject to study. Other family members highlighted as being influential were older siblings or cousins who had studied science and provided encouragement, and grandparents: 'My Grandpa liked chemistry (he worked on the railway) and was good at it – I wanted to please him' (Year 9 interviewee).

Although parents were said to be highly influential, a number of young people were at pains to point out that their parents wanted them to engage with, and work hard at, all their subjects, not just science: 'Mum wouldn't say specifically science, they would say for any subject, just try your best' (Year 11 focus group participant). Equally, most parents were reported to have encouraged, rather than pushed, young people into choosing science. Where parents were aware of, and supported, their children's choice of university course or future career, they were said to be particularly encouraging: 'My parents know I want to study science at university so they want me to do well in it so I can go' (Year 10 focus group participant).

A similarly large number of young people who referred to parental or family influence identified their **teacher** as either a positive or negative factor influencing engagement with science education. This resonates with previous research identifying the quality of the teaching experience provided as a key influential factor (Teaching and Learning Research Programme, 2006; Springate *et al.*, 2008; Butt *et al.*, 2010). Teachers who acted as a positive influence were reported to be those who made science lessons enjoyable, interesting and more understandable. Some teachers were described as being 'passionate' about their subject, which helped to inspire young people. Others had encouraged their students to think about further study or a career in a science-related field by talking about their own experiences, or by discussing available options and helping the young people to access useful and appropriate information.

Young people could be discouraged from studying science through what they identified as poor teaching, for example: an inability to make lessons interesting; not providing

enough help or encouragement; putting students down; and expecting students to copy down notes from the board. Also highlighted as negative influences were teachers who had discipline issues in class, which was said to stop more motivated pupils from learning and led to what was described as 'a doss lesson' (Year 11 interviewee). Two out-of-education interviewees recalled behavioural difficulties in science classes being compounded by the lack of a permanent teacher and supply teachers' inability to control the class. Some young people who were committed to studying science because of their future study or career choice, whilst commenting that poor teaching made the lesson less enjoyable, were at pains to say that this would not deter them from studying science 'because I need this for my future' (Year 12 interviewee).

The strength of feeling from the young people regarding the effects on engagement engendered by the quality of the teaching experience would appear to underline the importance, highlighted in the literature, of the supply and retention of well-qualified, experienced and motivated science teachers.

Young people rated **friends** as being far less influential significant individuals than either family members or teachers. Whilst in agreement that it was always good to have friends on the same course, most agreed that they would not let this deter them from what they really wanted to do.

A lot of my friends tried to persuade me to change my mind and do other courses – it was hard because I wanted to be in with them, but I also wanted to do the [science] course.
Year 10 interviewee

3.5 Personal perspectives/outlooks

Several young people reported being influenced to engage with science education as a result of their personal perspectives or outlooks (i.e. motivations intrinsic to them as individuals, such as enjoyment or interest, perceptions of difficulty/ability and images of science).

The strongest intrinsic motivation was identified as **enjoyment/interest**. Science was felt to be something young people either enjoyed and were interested in (which was often influenced by their ability in it), described as 'an addiction to knowledge gathering' or 'a sense of discovery' (Year 12 interviewees), or did not: 'I just didn't find it interesting and didn't pursue it as a result' (Year 13 interviewee); 'Interest is the key. If you like it at GCSE, you'll go on to do it at A level and so on' (Year 13 interviewee).

If you do science at GCSE then you either like it or you don't and that is what will make you decide to carry on with it or not in the future. Anything else is just a waste of time really – if people like it they will do it.
Year 12 interviewee

Young people felt the key here was to engage pupils' interest early on in their secondary school career by showing them how enjoyable science could be, and then maintaining that interest. Otherwise, 'people might drop out too young before they realise it's important and then it would be too late' (Year 12 focus group participant).

There was agreement that engagement in science was often influenced by perceptions of the **difficulty** of, and pupils' **ability** in, the subject. As already noted, pupils identified that science involved a lot of hard work and studying: 'You have to know that you want to

learn science, you have to have the right mindset to study it – not everyone is academic’ (Year 13 interviewee). As a result, there was believed to be a need to change the misconception that science was only for more academic students: ‘[Young people] might be put off if they think they’re not clever enough, but you don’t have to be clever – just have common sense’ (Year 10 interviewee).

There were mixed feelings about the **image of science**. Some young people felt that science had a positive image: scientists were seen as being intellectual and well respected. Others, however, felt that science had a more negative image amongst their peers. It was seen as too academic and therefore not fun or creative, whilst scientists were seen as ‘nerds’ or ‘geeks’, ‘people who don’t socialise much or do anything interesting’ (Year 13 interviewee). However, although it was agreed that negative images might put some young people off studying science, it was not felt to be a major factor influencing engagement.

They’d give like ‘Get back to your geek lessons’ and I was like ‘Yeah, I will, don’t you worry about me – I’ll be ringing you up later in life when I’ve got a good job and then we’ll laugh about it’.

Out-of-education interviewee, 19

Key points from the research

- This research has confirmed the value accorded to science education by young people during, and post, compulsory schooling. Science was regarded by many as an essential component in their portfolio of skills and qualifications, one that can help secure successful post-school progression in both science- and non-science-related destinations. Pupils suggested that success in science at school would enhance their chances of securing places at (more prestigious) universities. There is, however, a strong indication from young people in this study that such benefits are not always made clear enough to them.
- Young people in this study expressed a preference for more practical, hands-on activities, which they believed made learning science more interesting and subsequently easier to understand.
- Science was seen as being content heavy with more work involved than for other subjects. Equally, the assessment strategy used in science was felt to be particularly examination focused and set at a very high standard. Young people indicated that more continuous assessment and feedback would encourage engagement and subsequently learning.
- There was also a clear indication in the current research, that young people would be more engaged with science if it were more applicable and relevant to contemporary life.
- Young people in the current study identified the quality of the educational experience provided by the teacher as a factor influencing engagement with science education. The study also presents young people’s views on what constitutes ‘good’ and ‘poor’ teaching:
 - Teachers who acted as a positive influence on attitudes towards science were reported to be those who: made science lessons enjoyable, interesting and understandable through their passion for their subject; or by helping young

people to access appropriate information and advice about further study or a career in a science-related field.

- Conversely teachers who acted as a negative influence on attitudes were those who put students down; did not offer enough help or encouragement; expected students to just copy down notes; or had problems with discipline.
- This clearly underlines the importance of the supply and retention of well-qualified, experienced and motivated science teachers, supported by subject-specific and high-quality professional development.
- The current research clearly shows that young people would welcome a greater emphasis on careers guidance and on the use/value of science at an earlier stage in their school life. Maintaining and capitalising on that early interest may be more challenging, given the constraints of an already overloaded curriculum.

4. Science in society and science careers

What does the literature say?

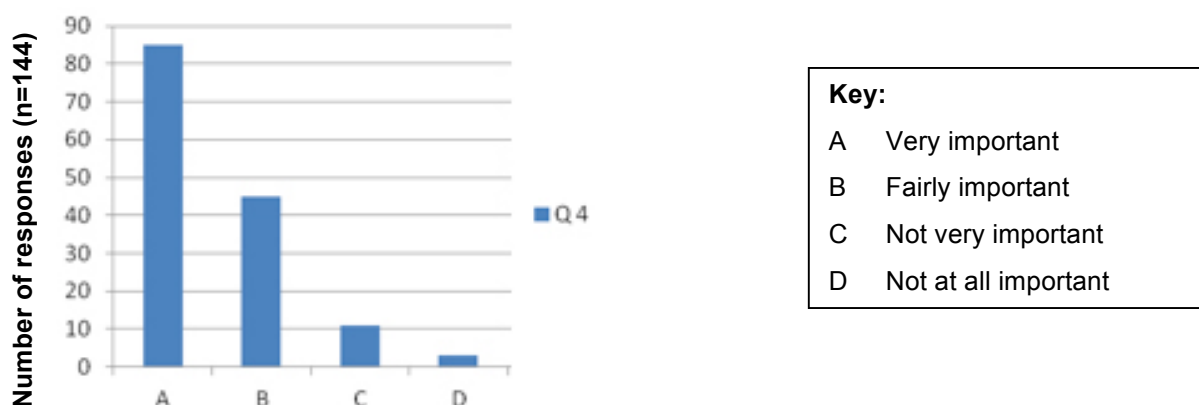
- Nearly all the young people interviewed in the Wellcome Trust Monitor thought it was, at the very least, 'fairly' important that science is taught in schools up to the age of 16, while more than half thought it was 'very' important (Butt *et al.*, 2010).
- The literature highlights the difficulty that many young people have in recognising the links and connections between science and their everyday lives (Osborne and Collins, 2000; Butt *et al.*, 2010). Indeed, young people often cited a lack of relevance and applicability in the science curriculum as a reason for disengagement from the subject (Osborne and Collins, 2000; Williams *et al.*, 2003; Cleaves, 2005; Barmby *et al.*, 2008; Springate *et al.*, 2008). Murray and Reiss (2005) contended that the science curriculum could be improved by ensuring greater connection with real-life situations and ethical issues.
- However, more than half the Year 9 students in Bennett's (2008) study thought that science education provided useful knowledge for post-school life, particularly because it was believed to affect so many things in our everyday lives.
- Bennett (2008) reported that two-thirds of the Year 9 students surveyed agreed with the view that science had a positive influence on society, mainly because of the medical advances it engendered. This echoes the study by Jenkins and Pell (2006) who found strong agreement amongst the students involved that science was important in discovering cures for diseases such as cancer and HIV/AIDS, and ensuring a healthier society.

4.1 Introduction

This chapter explores young people's views on the value of science education for them personally and for society in general. It looks at the importance of learning science in school, its value in their everyday lives and for their futures in terms of further study or careers, as well as the wider value of science education.

4.2 The importance of learning science at school

Figure 3: Focus group participants' responses to the question: 'How important is it that science is taught in schools to the age of 16?'



Teacher commentary:

Teachers presented a range of opinions regarding the compulsory nature of science education. Some suggested that pupils could benefit from having greater freedom of choice in the subjects they chose. Others contended that by ensuring that they study science, there is more chance that pupils will engage in it, enjoy it and benefit from it.

The majority of focus group participants and interviewees thought that learning science was important and beneficial in terms of:

- direct relevance for future career intentions
- value in terms of accessing and securing ('quality') university places
- providing relevant knowledge necessary for real-world employment
- providing general knowledge underpinning everyday life
- providing enhanced research and analytical skills.

Learning science was deemed important because it could help students with their future careers in some way, whether this was getting into university, or getting a job: 'so many career choices involve science'. There was the perception that by having a science qualification they would be seen as more desirable by universities and employers, and because 'most jobs use science at a basic level'.

Young people thought science was important because of the universality of its scope and application: 'It helps you understand the things around you', and 'expands your knowledge'. It was also suggested that they had a better understanding of issues they saw on television news and documentary programmes and some noted that science was important because it had an everyday relevance: 'Science is in everything'; 'Science helps us understand the world around us'; 'People overlook science and don't realise how important it is' (out-of-education interviewee).

In terms of the importance of scientific thinking in everyday life, one interviewee commented:

The thing that was drilled into us at the beginning was that every time you do an experiment, you have to keep one thing constant and change something else. Science gives you a basic grounding in analytical skills thinking. Everybody will

have applied that in some circumstances, like when you get a new TV remote and you don't know what the different buttons do, you keep pressing different buttons, keeping one the same until you work out what they all do.

Year 13 interviewee

It was also suggested that learning science had also helped students to develop an array of technical and analytical problem-solving skills, as well as increasing their ability to work collaboratively with others in practicals and experiments.

A minority of young people did not think it was important to learn science in school, citing the perceived lack of relevance of this subject unless it would be needed for a science-related occupation, such as medicine or chemical engineering. Many of those from the out-of-education cohort noted that, when they were at school, they did not generally see the importance of learning science because it did not appear to be directly useful to them. Modifications to the curriculum could, it was suggested, increase perceptions of the importance of this subject:

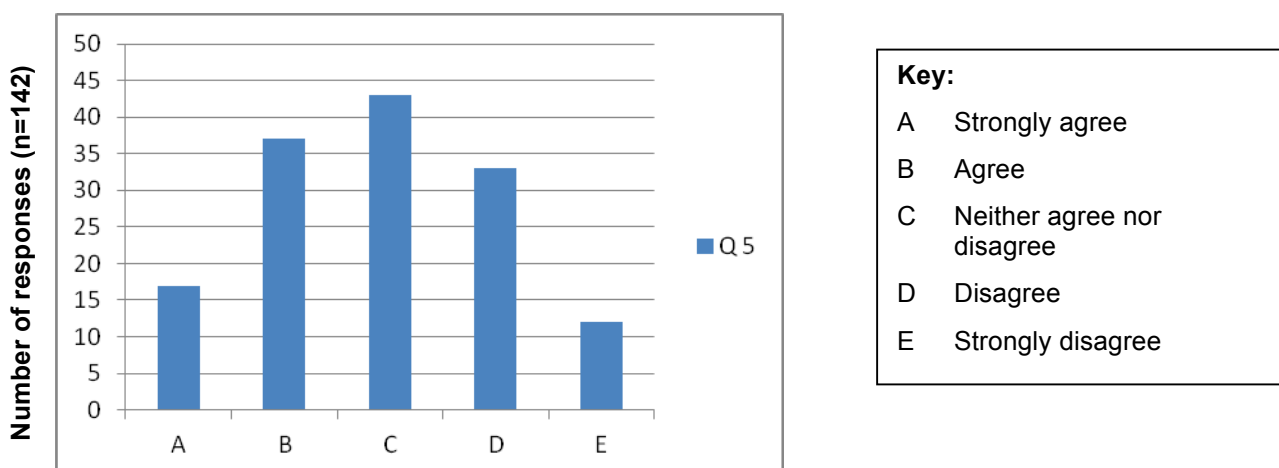
If they taught people things they cared about they would pay more attention, like, lots of young girls they dye their hair, so they could show you what sort of chemicals they are putting on it and the effects of what they are doing. They could show what's in certain drugs, and what happens if you get shot or someone stabs you.

Out-of-education interviewee, 17

4.3 The uses and applications of school science in everyday life

The focus group discussions generally revealed a neutral position regarding the usefulness of science learnt at school in young people's everyday lives. This is illustrated in the chart below and was also reflected in individual interviews.

Figure 4: Focus group participants' responses to the question: 'In day-to-day life I rarely use the science learnt at school'



There was agreement that science was useful at a macro level, in that it could underpin students' understandings of the issues surrounding global warming, renewable energy, new technology and the mechanics and impacts of natural phenomena such as earthquakes and volcanoes, for example. On a more individual level, some suggested that scientific knowledge was useful for generating understandings of health, nutrition, personal safety and issues such as smoking and drugs, and alcohol misuse. Science

education could, therefore, provide students with enhanced insights and general awareness of the world around them, but the actual scientific concepts were of less direct value. One student, for example, suggested that learning about iron ore in chemistry had no direct bearing on his everyday life, but acknowledged that iron is used to make steel which is used for cutlery and this is something used every day. Some young people also highlighted elements of the science curriculum that they perceived would be of little use to them:

Some bits of science will never be relevant to everyday life, like in biology we looked at the angle between hydrogen and oxygen, I mean when will I ever need that?

Year 11 interviewee

Examples were given that illustrated when and how elements of this knowledge had been applied in their everyday lives. For some, this connection was more problematic than for others as it was contended that 'you don't realise all the ways that you are using science' and that: 'Science use is not as visible, people don't realise they are using it until it's pointed out' (Year 11 interviewee). The majority, however, were able to illustrate some ways in which scientific knowledge was applied.

A large proportion of these responses focused on health, cooking and nutrition (for example, how to prepare food, the additives that are in food, GM food, basic hygiene and understanding illness better): 'We are learning about antiseptics and antibiotics currently in biology – now we know why we have to wash our hands and how it works' (Year 10 interviewee). Other examples focused on being able to understand the mechanics of household items, such as vacuum cleaners, or cars or painkillers. Students also associated their scientific knowledge with leisure activities, such as bowling:

You learn how friction affects how well you do it and can alter technique and basic physics helps you with things like you can judge how high or far to throw a ball in games. You don't realise you're thinking about science connected to it, you just do it.

Year 10 interviewee

Young people also suggested that they were better able to understand everyday science communication, for example, understanding science reports on television, or being able to understand science exhibitions at museums. The skills learnt through science lessons at school were also seen to have a direct application in everyday life.

The way the lessons are taught – like working together – gives you some interpersonal skills, like group work to do experiments. The other subjects are more independent learning. Science gives you these alternative skills.

Year 11 interviewee

Teacher commentary:

Teachers agreed that pupils could find it difficult to make connections between the science they learned at school and their everyday lives. Reasons for this included constraints imposed on curriculum content by examination syllabuses and the experiences of individual pupils. One teacher, for example, referred to a lesson involving discussion of the ways in which climatic conditions in a greenhouse could be modified. Many pupils would not be able to relate to this as they had not had experiences of greenhouses. Similarly, there was a view from some teachers that pupils were not always interested in understanding the science behind

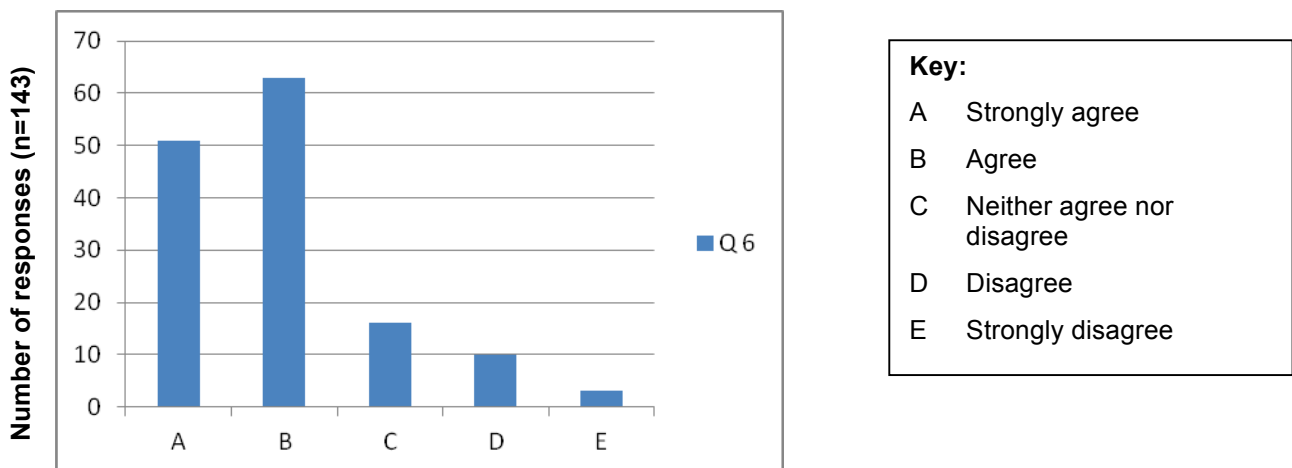
artefacts and processes they used in their everyday life, they just wanted to use them. Mobile phones were cited as an example of this.

Several teachers noted that television programmes could help to develop the relationship between science and pupils' everyday lives, helping to contextualise their scientific knowledge and understanding. There was an agreement that individual teaching and learning styles had a role to play in making science education appear more relevant. One teacher suggested that the scientific principles being taught had not changed, just the examples and frames of reference required updating

4.4 The value of science education for young people's futures

Beyond the general application of scientific knowledge, young people made direct linkages between the subject and their own futures. Focus group participants were generally in agreement that a good understanding of science could improve future career prospects, as shown in the chart below.

Figure 5: Focus group participants' responses to the question: 'Having a good understanding of science will improve a person's future career prospects, even if they don't go on to have a career in science'



Across the sample, young people with well-defined career aspirations, such as those wishing to pursue medicine and teaching, for example, noted that science education was of critical importance. Young people who were undecided about their career still identified the potential value of science education in terms of (i) 'keeps my career options open', and (ii) increasing their portfolio of skills and enhancing their position in future job markets. For example, it was suggested that:

Science is better recognised as a qualification by employers and it has higher status than other subjects. It shows you are smart and it demonstrates to employers the skills you have developed, like problem-solving and data analysis.
Year 12 interviewee

Across the sample, young people highlighted a range of views about the relative projected value of science education and other subjects in relation to life outside school. There was a general consensus that maths and English were the key subjects at school, with English often being said to be slightly more useful than maths because 'English is needed for everything, like writing letters and filling in forms' (Year 10 interviewee).

Understandably, those suggesting that science had a greater potential value than other subjects were largely those with the most advanced and clearly defined career intentions that required scientific knowledge. Over and above science education/intended career relationship, students rated the importance of science higher than that of other subjects because of the universality of its reach: 'Science is linked to everything'. Science was said to have greater societal impacts (such as medical discoveries) while the study of science necessitated and promoted the development of academic skills:

The logical processes are highly valuable – the process of learning something, rather than the actual content matter. This is important for the development of the intelligence of people.

Year 12 interviewee

4.5 Attitudes towards undertaking further study in science and pursuing a science career

A range of opinions was expressed regarding the likelihood of young people continuing their involvement with science education. For some, completion of GCSEs would mark the end of science education as a result of science no longer being compulsory and that it was seen to be of no relevance or hold no personal interest for them. For other students, particularly those who were possibly considering a science-based career, further study was a more likely, if not obvious, route. Of the students who remained undecided, the key factors determining the possibility of further study included the outcome of GCSE-level examinations; thoughts on future careers; and perspectives on the extent of personal interest in the subject.

The majority of students interviewed suggested that they would consider a career in science, although many were not yet entirely certain which specific job they would like to do. A science-related career was appealing as it was seen to offer wide-ranging and varied opportunities for future employment; could have wider societal impacts and benefits; could carry respect and financial reward; and certain jobs, such as those connected with forensic science, were regarded as being 'cool'. Potential jobs and career areas highlighted by students are presented below:

- | | | |
|----------------------------|------------------------------|-----------------------|
| • medicine (most popular) | • genetics | • microbiology |
| • optometry | • chemist | • physiotherapist |
| • pharmacy | • architect | • engineering |
| • electrician | • science research/lecturing | • physicist |
| • science teacher | • PE teacher/sports coach | • midwifery |
| • computer science | • psychologist | • pilot |
| • zoo keeper | • forensic science | • dentistry |
| • machine operator | • veterinary medicine | • neurosurgeon |
| • nursing | • welding/fabrication | • marine biologist |
| • environmental management | • sports science | • animal conservation |

Certain disincentives to pursuing a science career were also highlighted, involving the length and complexity of study involved, and some negative experiences of science and science education at school. Some school students and those out of education

suggested that they had not received sufficient high-quality information about the careers opportunities consistent with studying science:

I think a lot of people will be surprised by the number of careers in science. Many people probably don't know about it. Even things like doing research and surveys, that's science.

Year 11 interviewee

It is apparent that many students did not have a comprehensive view of what constitutes a science career, with one young person, for example, suggesting that: 'there are not many careers about science' despite being interested in becoming involved in either catering or the hair and beauty treatment industry. It was contended that 'science is not at all helpful for that'. Hence a common theme expressed by school-based interviewees and those out of education was that more could be done to inform young people better about the potential benefits and career opportunities associated with learning science.

If it were visible that more jobs people do are related to science then more people would want to look into it. At school you are only told about being a scientist, but it would help to know there are a lot more jobs available if you have the qualification.

Out-of-education interviewee, 17

4.6 Young people's perspectives on the wider value of science education

Young people thought that studying science was beneficial for society because it helped people to develop general knowledge and awareness of the world around them: 'It is really good for the future of society; it sort of makes the world go round really' (Year 11 interviewee). Environmental issues, such as sustainability and strategies to tackle global warming, alongside medical and technological discoveries, were highlighted as areas where science education could be particularly valuable for wider society.

Yes, [science] is beneficial in many ways – we need medical research to find cures, we need knowledge in geographical sciences to understand tectonic plates, understand earthquakes, and to build better structures that can withstand earthquakes and generally protect humans.

Year 11 interviewee

In addition, science education could contribute to promoting improved standards of personal health and well-being, for example, through increased knowledge of nutrition and healthy lifestyles.

Key points from the research

- Young people participating in this research generally supported the notion that learning science was valuable for both individuals and society. For individuals, the acquisition of scientific knowledge was seen to contribute to their own personal development in terms of supporting real-world awareness and delivering specific substantive understandings.
- Pupils revealed overwhelming support for science education in school to be compulsory, reflecting the acknowledgement that the subject carried with it significant importance and value for scientists and non-scientists because of its universality of application.

- In addition, the current research also confirms that pupils, whilst agreeing that science education is important, have difficulties in making direct links and associations between what they learn at school, and how they apply this in everyday situations. Thus, this research has indicated that there may be scope for increasing pupils' understandings of how the science they learn at school can be of direct relevance and application in their everyday lives.
- Similarly, different areas of the science curriculum were seen to have varying degrees of use and relevance, with many students questioning the value of in-depth study of theoretical concepts in favour of more readily accessible topics and activities. To increase engagement with science education, perhaps further investigations of how to enhance this linkage and these perceptions would be valuable.
- Young people in the current study highlighted the relationships between the technical skills and knowledge gained through science education and future employment opportunities. The majority of young people thought that science-related careers could provide rewarding employment, although a relatively limited range of possible jobs was revealed. Those with less successful school careers were least likely to see the benefits and relevance of science education for securing employment, with maths and English been seen as the critical qualifications required by employers. Increased focus on career development and the role/value of science education earlier on could help to address this.

5. Science outside the classroom

What does the literature say?

- Education outside the formal classroom setting can be defined, in its broadest sense, as any structured learning experience that takes place beyond the classroom environment during the school day, after school or during the school holidays (DfES, 2005). It can include (amongst other activities) cultural trips, science and geography fieldwork, environmental and countryside education, adventure group activities, learning through outdoor play and visits to museums and heritage sites (Education and Skills Select Committee, 2005).
- A number of benefits resulting from learning and experiences outside the classroom have been noted in the literature, including individual growth and improvements in social skills, impacts on attitudes, beliefs and self-perceptions and, to a lesser extent, the development of more general and specific academic skills. Also observed were improvements in engagement and achievement, alongside the promotion of positive behaviour (Rickinson *et al.*, 2004; Dillon *et al.*, 2005). Out-of-classroom experiences can enhance and improve the learning and understanding of science (Teaching and Learning Research Programme, 2006).
- Bennett and Hogarth (2005) reported some evidence that attitudes to science outside school may be more positive than attitudes to school science, although few of the young people in their study voiced any interest in reading science-related books other than school textbooks.
- The Wellcome Trust Monitor (Butt *et al.*, 2010) found that over half the young people interviewed had visited a place of scientific interest in the last year. The most popular places to visit were zoos and science museums. The Teaching and Learning Research Programme (2006) noted that science in science museums, zoos and hands-on centres was often perceived as 'exciting, challenging and uplifting' (p.6).
- The Monitor noted that young people who watched television were more likely to choose fictional rather than factual programmes. Young people were also more likely to use the internet than read a newspaper or watch television regularly (Butt *et al.*, 2010). However, just under a third of the young people in Bennett's (2008) study said that they enjoyed watching science programmes on television.
- Pupils in the study by Osborne and Collins (2000) reported that television, newspapers and magazines made science more accessible "through the use of visual images and content presented "in an interesting way" with a degree of detail, but "not boring detail, not too complex" (p.46).
- However, for science outside the classroom to be a rewarding activity that enhances student outcomes, it needs to be 'purposeful and produce a record, and the work must be followed up later in the classroom' (Teaching and Learning Research Programme, 2006, p.7).

5.1 Introduction

This section presents interviewees' thoughts and perceptions on, and their involvement with, science activities and information beyond the formal classroom setting. It explores

young people's involvement in the informal opportunities presented through school (e.g. trips to scientific places of interest, fieldwork, group activities etc.) but also those with which young people have engaged independently of school (e.g. science-related visits, watching television, reading newspapers or using the internet).

5.2 Informal science opportunities presented through school

The majority of pupils in the case-study schools commented that they had undertaken at least one **school trip** or visit to support their science education, or that they would be doing so at some point in the future (for example, a planned science trip to Switzerland and another to a local brewery). Pupils reported visiting a wide range of different places, including places specifically designed to support science education, such as science discovery centres (e.g. Techniquest in Cardiff and W5 in Belfast) and science museums (e.g. Thinktank Science Museum in Birmingham and the Natural History Museum in London); as well as places where scientific principles can be applied (e.g. a theme park when learning about gravity in school, Magna Adventure Centre; and a film/photography museum). Pupils also identified visits to the coast or woodland areas for biological studies, and to industry-oriented sites, including a brewery and a power station. In addition, school pupils noted participating in lectures, workshops and conferences held in further and higher education institutions, usually organised by specific teachers.

Perhaps unsurprisingly, out-of-education interviewees had more difficulty recalling school trips with only half (ten) able to identify a particular venue they had visited (e.g. a space museum, a zoo and the British Museum). Others were either adamant that they had not been on any school trips, or could not remember going on any. Those reporting they had not been on any school trips commented that this was usually because of behaviour issues: 'We couldn't even be controlled in the classroom, let alone taking us out' (out-of-education interviewee, 22). Pupils still attending school also highlighted the opportunities for inappropriate behaviour afforded by trips out.

The majority of young people stated that school trips were fun and enjoyable, making science more interesting, increasing understanding and making topics more memorable for examinations. Some added that it was important to show that science can be applied to the outside world and that science education 'shouldn't be just about doing well in tests' (Year 11 interviewee). School science trips were also thought to be useful for careers, and for generating ideas and inspiration for further study.

However, young people were keen to point out that it was important that the trip did in fact support learning in the classroom, providing a deeper level of understanding, otherwise there was no point – it would be a fun day out of the classroom, but with no application to learning. For example, one out-of-education interviewee who had visited a space museum when in Year 9 had found the experience fun, but had been unable to see how it would be useful: 'We weren't learning about space, so it was pointless'. Some high achieving pupils in one case-study school suggested that school trips could sometimes detract from learning and reported a preference for remaining in school, generating knowledge through textbooks and independent study: 'Visiting a power station won't help learn about how it works any more than reading about it in a textbook' (Year 12 focus group participant). Some school pupils noted that while trips out were something to look forward to, too many might become repetitive. Time (due to the packed curriculum), cost, distance, the potential for poor pupil behaviour (as already noted) and the required teacher effort were identified by young people as often being the factors that prevented school trips from going ahead.

This would suggest that the need to ensure that school trips are engaging, relevant and serve as an enhancement of, not a distraction or a deviation from, learning is key to ensuring desirable outcomes.

Teacher commentary:

As in the case of practical activities in the classroom, teachers were positive about the potential role and impact of trips and activities in enhancing pupils’ experience of science education. Well designed and appropriately targeted trips were seen as helping pupils’ motivation as well as increasing their capacity to learn by providing a break from routine class-based activities. Provided they were integrated into the curriculum, trips could be effective in demonstrating real-world science applications to reinforce theoretical teaching.

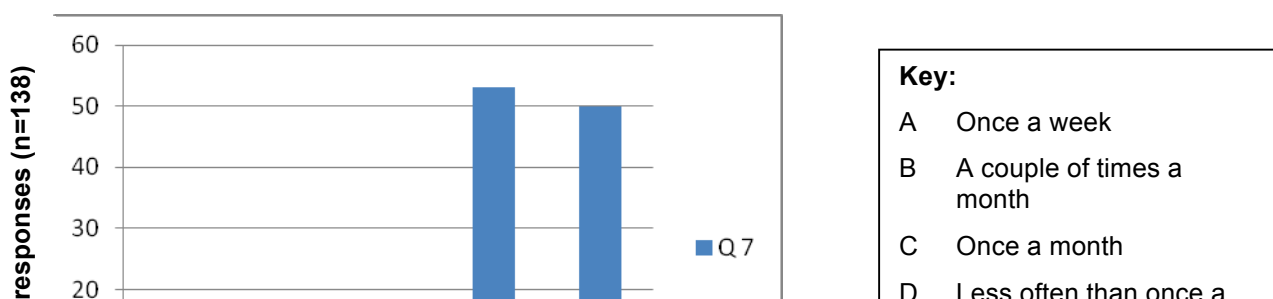
Young people were much less likely to identify opportunities for **activities outside the classroom**, but still within the school building or grounds. In one of the case-study schools, physics students had been able to see the practical application of learning about forces and propulsion when they had used the lift in the main part of the school building during their lesson. Out-of-education interviewees’ accounts of science activities outside the classroom included building rockets in class and then taking them outside to experiment with, and using the school gym for an activity on speed: ‘We shot tennis balls past a speed thing and tested different speeds of different weights’. Another out-of-education interviewee had been a member of the lunchtime science club at school and had enjoyed doing slightly more ‘funky stuff’, such as how to light a fire underwater.

Again, such activities were felt to be more enjoyable and memorable than classroom-based ones, thus enhancing the learning experience. Pupils suggested using the school grounds more for biology lessons, for example when studying plants or trees, for conducting learning walks and to provide practical demonstrations of the scientific concepts they were learning about in the classroom, for example, evaporation and propulsion. Pupils felt that teachers often used the excuse of insufficient time (given the amount of work to get through), health and safety issues, or inappropriate pupil behaviour as reasons for not providing activities outside the classroom. An example of the latter was given in one Year 10 focus group where a science class had gone out into the school grounds to conduct an experiment with Mentos sweets and diet cola. The pupils said they had become ‘over excited’ because these sorts of experiments rarely happened. At the same time, other classes had also been disrupted because ‘they were hanging out of windows’ in order to see what was happening. As a result, the class was never given the opportunity to participate in an outdoor experiment again. It had now become something of a ‘catch 22’ situation, as the pupils felt that if they had lessons like this more often, then they would be better behaved.

5.3 Informal science opportunities independent of school

It was evident that focus group participants rarely engaged in visits outside of school time as indicated in Figure 6 below. Interviewees also reported a similar lack of participation.

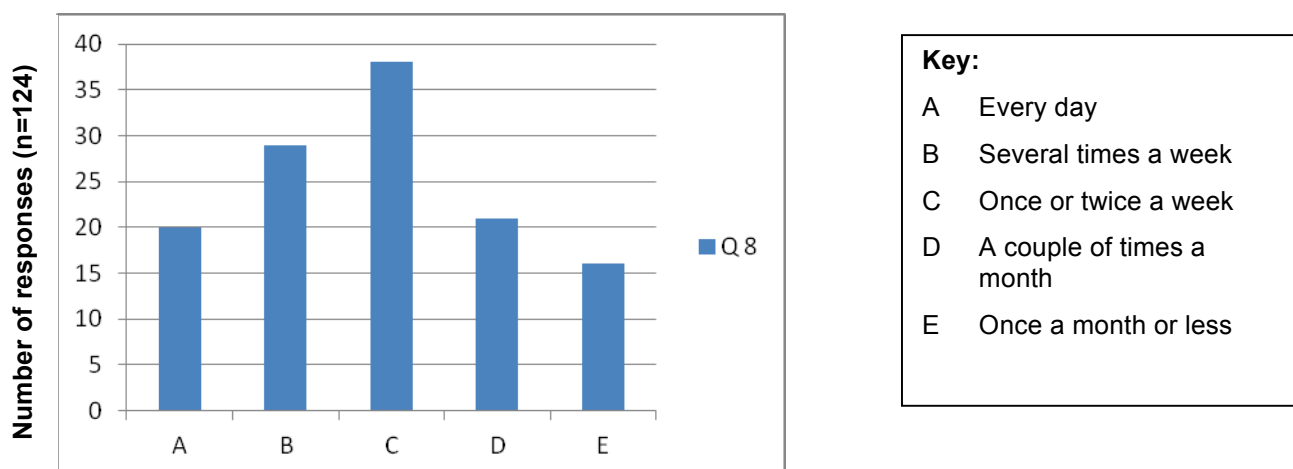
Figure 6: Focus group participants’ responses to the question: ‘How often do you visit places other than school to engage in science activities?’



A number of young people mentioned having been taken on **trips** or visits to places of scientific interest by their parents when they were younger. Interestingly, some referred to trips to zoos and animal parks but said that they would not really consider this to be a science-related visit. Few young people reported going on science-related trips now they were older, citing lack of interest, time and cost as reasons for this. It may well be that young people do not always fully recognise the opportunities to apply scientific principles, or see them in action, afforded through, for example, a visit to a theme park or adventure centre.

Several young people reported accessing science information by watching science-related programmes on **television**. These were thought to 'show the more interesting stuff' (Year 12 interviewee).

Figure 7: Focus group participants' responses to the question: 'How often do you watch science programmes on TV?'



Programmes highlighted by more than one of the young people included the following:

- wildlife documentaries
- *CSI*
- *Mythbusters*
- *Bang Goes the Theory*
- *Stephen Hawking's Universe*
- *Brainiac*
- *Horizon*
- *National Geographic*
- *Stargazing Live* (with Brian Cox)
- *Extraordinary People*.

Although many said that they watched some form of science programme, a lot of young people qualified this by saying that they would often either watch it because 'nothing else is on' or without realising that it was a science programme. The latter is neatly articulated in the following exchange within a Year 10 focus group.

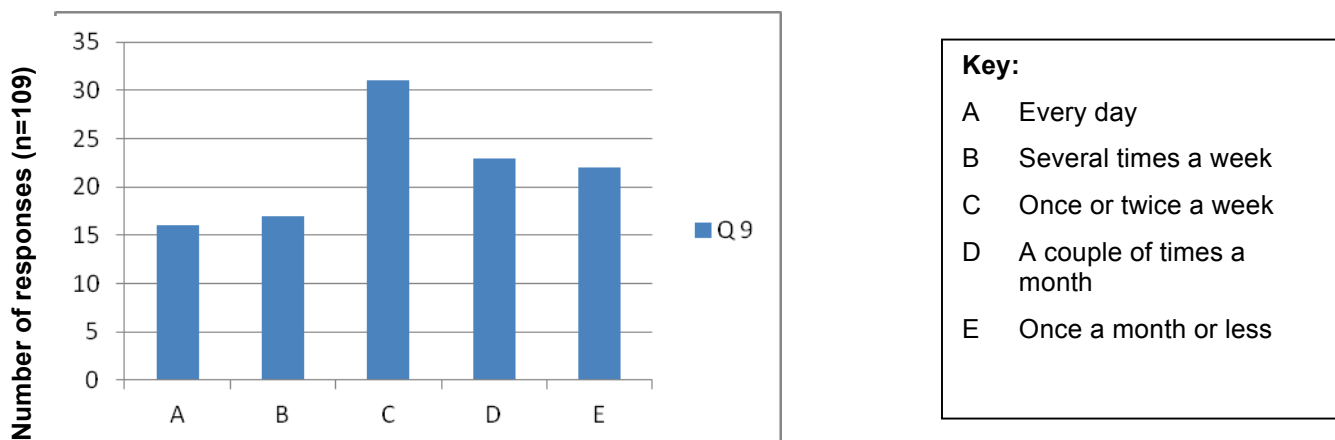
- Pupil 1: *I watch Bear Grylls when he's in the jungle and that. You see how he sterilises water to drink.*
- Pupil 2: *That's not science.*
- Pupil 1: *Yes it is – he uses the chemicals in plants and things. It's biology.*

Another pupil stated that there were any number of science programmes for younger children, but not many focused at A level students. Those pupils who did make a conscious decision to watch a science programme reported that this was because it was something they were particularly interested in (e.g. black holes, the Chilean miners' experiences or the Big Bang theory), or because it was related to, and could support, their area of study or future university/career intentions (e.g. medical, environmental or nature). News programmes on television were also seen as a way of expanding scientific knowledge.

Young people across the sample were less likely to access science information by reading **newspapers** than they were by watching television, as highlighted in focus

group responses below. However, this was more often than not because they simply did not read newspapers very often, if at all.

Figure 8: Focus group participants' responses to the question: 'How often do you read about science topics in newspapers?'



Most were in agreement that they would not make a conscious decision to look through a newspaper to find science articles, but would read them if they saw them. Some young people said that they would 'flick through' a newspaper and if a headline or a picture caught their interest then they would read the article.

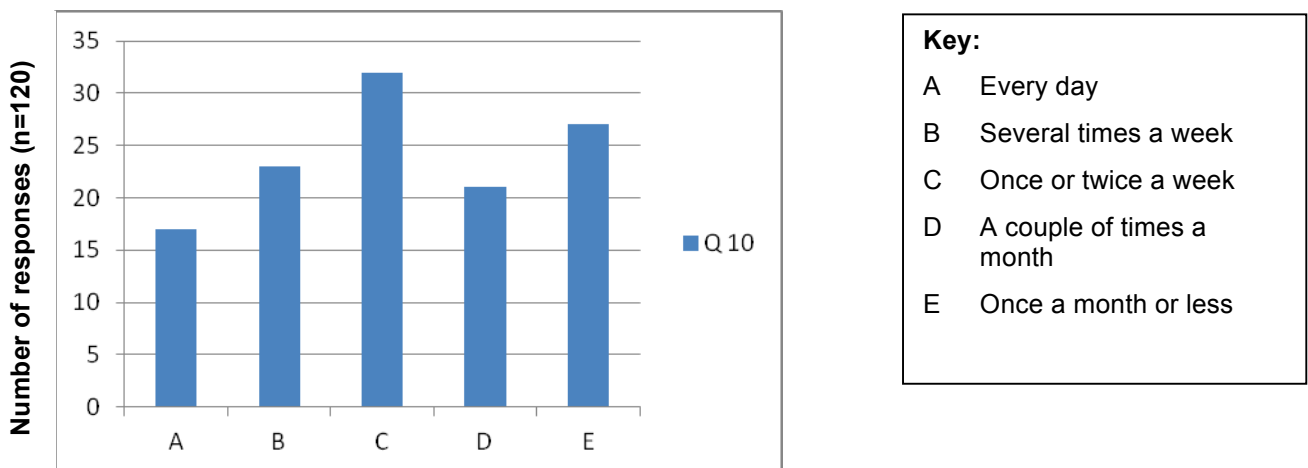
I read about the miners in Chile. That was about geology and measurements – finding out where they were and how to find them. There's biology as well – like their eyes have to be checked because of the dark, and their lungs are full of dust. When they were down there, they had NASA food specialists to help make sure they had the right diet to help them survive.

Year 10 focus group participant

A small number of students had subscriptions to scientific magazines (*New Scientist*, *National Geographic*), others referred to reading literature specifically related to a scientific career, in some cases in preparation for university interviews.

Young people reported being less inclined to look up science information in their free time on the **internet**, stating that they would only really use the internet for science if they had homework, research projects or coursework, and for revision (using online informal tests): 'Other than school stuff, I don't feel any need to look for information. School is school, and home is home' (Year 12 focus group participant). Such views are reflected in Figure 9.

Figure 9: Focus group participants' responses to the question: 'How often do you go on the internet to do activities relating to science?'



Websites used included BBC Bitesize (which was very popular), Wikipedia, and search engines such as Google and Yahoo. The internet was said to be 'instant and easier than the library', as well as being interactive. Young people also reported using it to look for different explanations if a topic was particularly difficult at school. However, a few young people did note that it was quite easy to become distracted and look at other sites when using the internet: 'If you are just sitting with your books, there is less opportunity for distraction' (Year 12 interviewee).

Teacher commentary:

Teachers expressed little surprise that pupils were not heavily engaged in the informal acquisition of scientific knowledge through television, newspapers and internet usage. However, there was a feeling that television especially could be a highly valuable teaching resource and that numerous, high quality programmes existed which were already being used to support curriculum delivery. This particular media was seen to be more readily accessible to some pupils than printed media, and one teacher noted s/he was continually monitoring television content to identify suitable programmes that could be used in his/her teaching. It was also suggested that some pupils were accessing science content via the internet, specifically from YouTube, and this was increasingly being integrated into teaching. Another teacher noted the potential of encouraging pupils to access knowledge through downloading podcasts and other material to their MP3 players.

Therefore, there seemed to be a distinction between what young people saw as 'science' and what they did in the rest of their time, apart from global understandings that some form of science underpins everything – for example, understanding that electricity powers computers and televisions etc. It could be suggested that greater use of new technologies such as social networking sites, for example, could be a way that science and its importance may be promoted.

Key points from the research

- Young people's views in the current research clearly demonstrate the need for science activities outside the classroom environment (for example, school trips) to be integrated into the overall delivery of the curriculum to ensure that they act as enhancement and enrichment activities and not just enjoyable, but possibly distracting activities.
- Young people in this study emphasised the 'fun' and enjoyable aspects of activities outside the classroom. Given the fact that personal interest is a key driver in their decision to study post-compulsory science (see Chapter 2), providing more opportunities for experiences outside the classroom environment could be a useful way of encouraging student engagement in science education.
- It was also clear, however, that young people did not always recognise the opportunities to apply scientific principles afforded through, for example, a visit to a theme park (such as forces or gravity). Making the links clearer may go some way to ensuring the greater relevance of science education to everyday, contemporary life.
- Several young people in the current study reported watching factual science-related programmes, although they did add the qualification that they might do so because nothing else was on, or because they did not realise it was a science programme. Young people were less likely to read newspapers to access science information, or to use the internet unless it was to support school work. Capitalising on the accessibility of television and the internet as a way of reaching young people and stimulating their interest in science could be a useful way forward.

6. Improving engagement with science education

It is clear that many of the young people in the current study were enthusiastic about learning science, appreciating both its value and relevance to their lives and possible future ambitions and opportunities. Those who were more engaged tended to be those who had greater levels of personal interest and ability in the subject. Equally, there were a number of factors that could either encourage or discourage young people from learning science including, for example, the learning context, significant individuals and personal perspectives or outlooks.

Hence, drawing on the themes highlighted throughout the previous chapters of this report, the following presents some recommendations, based on the amalgamated thoughts and suggestions made by young people, as to how engagement with science education could be improved in the future. In order to facilitate the analysis, views have been collated into the following thematic categories, which are not mutually exclusive and were often inter-related:

- making science more relevant and applicable to everyday life
- promoting science as interesting and fun
- provision of improved advice on the benefits of science education for future progression pathways
- pedagogical approaches.

6.1 Making science more relevant and applicable to everyday life

From young people's point of view, it is apparent that it is important to raise the profile of science education within the overall school curriculum and to enhance perceptions of its relevance and applicability to everyday life. There may be scope for exploring ways in which science can be better 'marketed' to young people, by focusing on the subject's image and potential relevance/usefulness to counter negative connotations.

Scientific concepts could be better explored in such a way that their connection to the real world is enhanced. Young people sometimes felt that they were accumulating knowledge solely in order to pass an examination because that connection had not been made explicit. As a result, this could impact negatively on their engagement with science. However, in doing so, it is also necessary to ensure that the content and academic rigour of science education is not compromised. In addition, it was noted that it might be profitable to update some of the reference points used in science education, to make better use of contemporary situations and contexts that may be more accessible and understandable to young people.

Making things more relevant to what is happening in the real world, like oil alternatives – it makes it easier to understand when it is related to real life.

Teacher commentary:

Teachers confirmed the need to think of newer examples and applications to make science education appear more relevant to pupils. There was a feeling that the topic of sustainability and energy conservation, for example, could have reached saturation point, being taught from primary age and throughout secondary school science. New examples could be more geared to specific industries. The recent rise of scientists presenting high-profile, prime-time

television shows about astronomy and other scientific content has helped some teachers change their reference points and provide examples and illustrations that pupils are more familiar with.

Teachers also suggested that the curriculum is still examination, target and policy-driven, so some suggested that the examination boards need to lend support to such an approach, otherwise teachers will be reluctant to deviate too far 'off topic'. It was noted that recent curriculum developments through, for example, the National Curriculum Review and the Curriculum for Excellence in Scotland, would help teachers to develop the curriculum and allow a modernisation of content and approach with an increased focus on active learning.

It was also contended that any developments in curriculum content or delivery need to be supported by appropriate staff development activities and investment – school staff need to be supported in learning about recent developments in science and methods of delivery.

6.2 Promoting science as interesting and fun

Young people's observations centred on the benefits of capitalising on, and demonstrating, the potential for science to be interesting, fun and engaging, so as to avoid potential negative perceptions of it as boring or difficult. There is a need to look for connections and build upon positive experiences of science education developed earlier on in young people's school careers. It was often noted that young people had enjoyed science at primary school because it appeared to be a fun and appealing subject. Hence, it is important to maintain and extend that early interest in order to encourage young people's engagement with the subject during and beyond the compulsory period. This could be done through enhancement and enrichment activities, including more practical and group work, and opportunities for learning outside the classroom.

I think just keeping everything interesting and keeping it exciting is a key in science.

It was also noted that young people may become more engaged in science when such activities take place outside of the formal classroom environment. One young person, for example, suggested that competitions between schools with a scientific theme could be an effective way of increasing young people's interest, such as designing and building go-karts to race, or devising prototype solar energy systems for the school.

Teacher commentary:

There was agreement amongst teachers that more attention could be given to increasing the 'fun' elements of teaching and learning through focusing more on enrichment activities to help increase pupil engagement.

Barriers to this were reported to include the already full curriculum, which imposed restrictions on the amount of time that could be devoted to practical activities, group work and learning outside the classroom activities, as well as the time required to devise and prepare meaningful and useful practical activities.

6.3 Provision of improved advice on the benefits of science education for future progression pathways

Young people called for earlier and improved information and advice about the connection between science education and potential future career paths. Currently, young people felt that they did not always have sufficient information to be able to make

informed choices. Engagement with science education could be increased by developing the nature and extent of the advice provided (e.g. by extending their knowledge of the range of career and study opportunities available to them through studying science), and delivering it at an earlier stage. In this way, science could be seen to be more meaningful and more directly useful for young people. Drawing on experts and practitioners working in science-related fields could be particularly beneficial.

Talking to people who work in the science areas would be useful, as well as the careers evenings – having some guest speakers coming in would be useful – how they have used science and what it has meant to them.

Teacher commentary:

Teachers agreed that there are potential benefits in providing careers and subject area advice at an earlier age, certainly pre-options choices. Some suggested this could be introduced at primary school by attempting to embed the importance of science education at an early age.

Teachers supported the idea of inviting professionals and experts to engage with pupils, including academics from universities and other educational establishments and a range of professionals and practitioners representing variety of industries and occupations. One suggestion was a variation of 'speed dating', where pupils had three or four minutes to ask a doctor, or engineer questions, before moving on to talk to another professional. The first-hand knowledge, experience and perspectives of these individuals could provide a valuable resource to help pupils realise the potential value of pursuing science education. Several teachers suggested that universities have a crucial role to play in this, given school staff's pressure in delivering the curriculum and achieving targets. One teacher highlighted that subject teachers had the responsibility for raising the profile of specific subjects in terms of pupils' individual career choices and progression opportunities, aided by computer software.

Belonging to a STEM network was also seen as a way of helping students engage with, and discover the value of science education. It was also contended that employers in the science community needed to recognise that changes in the skill-set and abilities of potential new employees may be required (such as the increasing importance of vocational qualifications and practical abilities, rather than a focus on degree-level qualifications).

6.4 Pedagogical approaches

It was suggested that developments in the way science is taught could increase young people's interest and engagement. Pupils were critical of the assessment strategy used in science, which was felt to be particularly examination focused. As well as the focus on assessment 'of' learning through summative testing, it may be that greater emphasis on the techniques of assessment 'for' learning (e.g. verbal and written feedback, peer and self-assessment etc.) would be beneficial. There was wide-ranging appreciation of, and support for increasing, the practical element of science lessons. This was felt to make the theoretical elements of the subject more accessible and understandable to young people. However, it was also seen as important to ensure that these practical activities were used as a purposeful part of an integrated teaching and learning approach rather than a standalone, 'fun' activity.

Closely related to this, engagement may also be increased when young people are provided with opportunities for greater interaction and participation in the lesson, rather than being the passive recipients of knowledge. Suggestions included learning in a

workshop/seminar style environment facilitated by teachers, practical experiments using more up-to-date equipment, discussion and debate, as well as opportunities for learning outside the classroom environment.

I think we do a lot of copying out from textbooks – this is really dull. It doesn't inspire people to take science further.

Teacher commentary:

Teachers offered varied responses in relation to pupils' perspectives on testing. Nearly all these teachers contended that formal testing through examinations would remain the primary means of assessment and that science teaching had to remain focused on this. Peer assessment was recognised as a potentially useful tool to be explored.

Teachers contended that practicals have value, and serve to enrich pupils' experience of, and learning in, science, if and when they are appropriate and integrated into curriculum delivery. There is a risk that practicals may distract pupils from learning if they are not properly devised and implemented. Interaction between teachers, pupils and the subject are still seen to be the key elements in effective teaching and learning approaches.

There was teacher support for the idea of encouraging pupils to participate in lessons actively, through practical activities, group work and class discussions. Having enthusiastic staff with the ability to motivate and inspire pupils to engage with, and enjoy learning science was seen as the most effective means of encouraging and supporting pupils' learning. Reinforcing this, one teacher suggested that new approaches – such as seminar- and debate-style lessons – may make some teachers feel as though they were operating outside their 'comfort zone'. Hence, continuing professional development (CPD) opportunities for existing staff members, and enhanced initial teacher training (ITT) content, may facilitate and support this

Clearly, young people appreciated teachers who can convey passion and enthusiasm for their subject. At the same time, there is a need to ensure the space and support within an already pressurised curriculum to enable teachers to deliver in these more innovative and engaging ways.

References

- Barmby, P., Kind, P. and Jones, K., 2008. Examining changing attitudes in secondary school science'. *International Journal of Science Education*, 30(8), 1075-1093.
- Bennett, J., 2008. Annual National Survey of Year 9 Students' Attitudes to Science: Final report October 2008 (Department of Educational Studies Research Paper 2008/01). York: University of York. Department of Educational Studies.
<http://www.york.ac.uk/media/educationalstudies/documents/research/Paper23Students'Attitudes%202008.pdf>.
- Bennett, J., Hogarth, S. 2005 Would you want to talk to a scientist at a party? Students' attitudes to school science and science. York: University of York, Department of Educational Studies.
- Butt, S., Clery, E., Abeywardana, V. and Phillips, M., 2010. Wellcome Trust Monitor 1. London: Wellcome Trust.
http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_grants/documents/web_document/wtx058862.pdf.
- Cleaves, A., 2005. Formation of science choices in secondary school. *International Journal of Science Education*, 27(4), 471-486.
- Department for Education and Skills (DfES), 2005. Education Outside the Classroom Manifesto.
- DeWit, J. and Osborne, J., 2008. Engaging students with science: In their own words. *School Science Review*, 90(331), 109-116.
- Dillon, J., Morris, M., O'Donnell, L., Reid, A., Rickinson, M. and Scott, W., 2005. Engaging and Learning with the Outdoors – the Final Report of the Outdoor Classroom in a Rural Context Action Research Project. Slough: NFER.
- Great Britain. Parliament. House of Commons. Education and Skills Select Committee. (2005). Government Response to the Committee's Second Report (Education Outside the Classroom) Sixth Report National Skills Strategy: 14–19 Education and Eighth Report (Teaching Children to Read) of Session 2004–5.
<http://www.publications.parliament.uk/pa/cm200506/cmselect/cmeduski/406/40604.htm>
- HM Treasury, Department for Trade and Industry and Department for Education and Skills (2004). Science and Innovation Framework (2004–2014). http://www.hm-treasury.gov.uk/media/95846/spend04_sciencedoc_1_090704.pdf
- HM Treasury, Department for Trade and Industry and Department for Education and Skills (2006). Science and Innovation Framework (2004–2014): Next steps.
<http://www.berr.gov.uk/files/file29096.pdf>
- Jenkins, E and Nelson, N. W., 2005. Important but not for me: students' attitudes towards secondary school science in England. *Research in Science and Technological Education*, 23(1), 41-57.
- Jenkins, E.W., Pell, R.G. 2006. The Relevance of Science Education Project (ROSE) in England: a summary of findings. Centre for Studies in Science and Mathematics

Education, University of Leeds. <http://roseproject.no/network/countries/uk-england/rose-report-eng.pdf>

Morris, M. (2006). Pupil subject choice in schools: a product for the Economic and Social Research Council.

Murray, I. and Reiss, M., 2005. The student review of the science curriculum. *School Science Review*, 87.

Osborne, J. and Collins, S., 2000. Pupils' and Parents' Views of the School Science Curriculum. London: King's College London.

Osborne, J. and Collins, S., 2001. Pupils' views of the role and value of the science curriculum: a focus group study. *International Journal of Science Education*, 23(5), 441-467.

Osborne, J., Simon, S. and Collins, S., 2003. Attitudes towards science: a review of the literature and its implications. *International Journal of Science Education*, 25, 1049-1079.

Oversby, J., 2005. What does research say about attitudes towards science education? *Education in Science*, 215, 22-23.

Owen, S., Dickson, D., Stanisstreet, M. and Boyes, E., 2008. Teaching physics: students' attitudes towards different learning activities. *Research in Science and Technological Education*, 26(2), 113-128.

Reiss, M., 2000. *Understanding Science Lessons: Five years of science teaching*. Buckingham: Open University Press.

Reiss, M., 2004. Pupils' attitudes towards science: a long-term perspective. University of London. Institute of Education. <http://eprints.ioe.ac.uk/94/1/Reiss2004Students97.pdf>

Rickinson, M., Dillon, J., Teamey, K., Morris, M., Choi, M., Sanders, D. and Benefield, P., 2004. *A Review of Research on Outdoor Learning*. Shrewsbury: Field Studies Council.

Roberts, G., 2002. SET for Success: The supply of people with science, technology, engineering and mathematics skills. http://www.hm-treasury.gov.uk/media/F/8/robertsreview_introch1.pdf

Sainsbury (2007). *The Race to the Top: A review of government's science and innovation policies*. HMSO. http://www.hm-treasury.gov.uk/d/sainsbury_review051007.pdf

Smithers, A. and Robinson, P., 2008. What can be done to increase the take-up of A-level physics? *School Science Review*, 89(328), 49-59.

Springate, I., Harland, J., Lord, P. and Wilkin, A., 2008. *Why Choose Physics and Chemistry? The influences on physics and chemistry subject choices of BME students*. London: The Institute of Physics and Royal Society of Chemistry. <http://www.nfer.ac.uk/nfer/publications/AUC02/AUC02.pdf>

Stagg, P., Laird, R. and Taylor, P, 2003. Widening Participation in the Physical Sciences: An investigation into factors influencing the uptake of physics and chemistry. Final report. Coventry: The University of Warwick, Centre for Education and Industry.

Teaching and Learning Research Programme (2006). Science Education in Schools: Issues, evidence and proposals. A commentary by the Teaching and Learning Research Programme. London: Institute of Education, Teaching and Learning Research Programme [online].

http://www.tlrp.org/pub/documents/TLRP_Science_Commentary_FINAL.pdf

Williams, C., Stanisstreet, M., Spall, K., Boyes, E. and Dickson, D., 2003. Why aren't secondary students interested in physics?. *Physics Education*, 38(4), 324-329.

Appendix 1: Out-of-education interviewees (characteristics)

	Age	Current status	Year/age of leaving school	Qualifications gained
1	17	In training: Currently studying for an NVQ level 3 in Sports Coaching	2009 (in Year 11)	NVQ level 2 in Sports Coaching Business BTEC (4Cs) GCSEs: Science (3Cs); Maths (E); English language (E); ICT (grades D and E)
2	17	In training: Apprenticeship for motor vehicles at Volvo	2010	GCSEs: Maths; English; science and PE (cannot remember the grades)
3	18	In training: 12-week Prince's Trust course leading to an NVQ in community work	2008	GCSEs: maths (C); English (C); drama (B); business studies (D)
4	17	In training: Just finishing a course in hairdressing at college, will be trying to find an apprenticeship	Aged 15	None
5	19	Currently unemployed: looking for a suitable college course to join	2007	GCSEs: English language; English literature; RE; maths; single award science (F); geography; history; business studies (no other details of grades given)
6	16	Currently unemployed: just left school and looking for a suitable college course to join	2010	'Some' GCSEs: science; drama; maths; English; IT; PE mentioned (no details of grades given)
7	17	Currently unemployed	2009	GCSEs: science (C); maths (C); business studies (C)
8	19	In training: Prince's Trust course	2009 (aged 18)	A levels: further maths (A); maths (A); chemistry (A); economics (A); critical thinking (A)
9	18	In training: 12-week Prince's Trust course leading to an NVQ in community work	2008	GCSEs: English (C); maths (C); science (D); food technology (D); art (B) Other: IT (level 2); preparation for life (level 2); first aid course and Duke of Edinburgh Award (bronze)
10	19	Working: as a part-time model	Aged 15 (to have a baby)	GCSEs: English; maths; single science (thinks it was physics); PE; child development; art
11	22	Currently unemployed: no full-time job, some part-time work for a construction agency when needed	Aged 16	GCSEs: double science; English; maths; PE; drama; music. OCR French, art, PE and bodybuilding (mainly Cs and Ds for all)
12	17	Currently unemployed: looking for either a hairdressing or mechanics course	Year 10 (to have a baby)	GCSE science ('I think')
13	17	In training: a college course in fabrication	Aged 15	GCSEs: science (C); a few Es
14	18	Currently unemployed	(no detail)	(no details given)
15	16	In training: three-month Prince's Trust course	2010 (aged 16)	GCSEs: art; music; geography (no details of grades given)
16	20	Currently unemployed: went to college last year to study childcare, science and maths	Aged 16	GCSEs: four including science (grades C and D)
17	19	In training: Prince's Trust course	2008 (aged	None

			17)	
18	16	In training: 12-week Prince's Trust course leading to an NVQ in community work	2010	GCSEs: maths; English; science (combined); art; drama (no details of grades given)
19	18	In training: Apprenticeship in Business Administration	2008	GCSEs: an A; two Bs; three Cs (science); four Ds
20	17	In training: Prince's Trust course	2010	GCSEs: four Cs; one F; one G; one GG

Appendix 2: Research instruments

A2.1 Questions used in focus groups in schools

The focus groups included a mixture of verbal questions to the group as a whole and a number of questions that pupils answered individually via the Audience Response System (ARS). This system is designed to engage young people using *Who Wants to be a Millionaire?*-style keypads. ARS allows participants to give their views in a confidential manner, whilst still allowing group discussion of the topics. ARS is an innovative, fun yet confidential way of collecting data from groups of people. It enables researchers to pose questions which are displayed on screen and participants privately select their answer on a personal keypad. It ensures that all those being consulted respond rather than a few dominating the discussion. Overall responses can then be displayed instantly on a screen to the group to facilitate interaction. This acts as an initial ice breaker in order to help pupils formulate their ideas and stimulate the subsequent discussion.

ARS Q1) Overall, how much do you enjoy studying at school?

1. I really enjoy it.
2. I quite enjoy it.
3. I don't find it very enjoyable.
4. I do not enjoy it at all.
5. It varies.

1) What is/are your favourite subject(s) at school?

ARS Q2) Overall, how interesting do/did you find science lessons at school?

If you are no longer learning science, please think back to when you were doing so.

1. Very interesting
2. Fairly interesting
3. Not very interesting
4. Not at all interesting
5. It varies between science subjects.

2) Do you enjoy learning science?

Question prompts: Why? What would make it more enjoyable/interesting?

3) Do you find learning science easy or difficult?

Question prompts: Why? What would make it easier for you?

4) How does science compare to your favourite subject(s) at school? [*Rephrase if science is their favourite*] What makes it different? What makes it different to English and/or history?

*Question prompts: Find out about **comparisons with other subjects** in terms of the classroom experience, the content (in terms of both knowledge and skills), the ways in which it is taught, the homework, opportunities to do things outside of the classroom etc.*

5) What, if anything, has encouraged you personally to learn science? How/why?

Question prompts if needed: Enjoyment of subject, friends, teacher, practical work, relevance to real life, benefits for future study/career, parents' encouragement etc. Why/in what way(s) have [these factors] encouraged them?

ARS Q3) How important do your parents think it is for you to do well in science at school?

1. Very important
2. Fairly important
3. Not very important
4. Not at all important.

6) What, if anything, has/would discourage you personally from learning science? How/why?

Question prompts if needed: Level of difficulty, friends, poor teacher, no opportunity for practical work, lack of relevance to real life, no benefits for future study/career, too much written work/homework, negative image of science/scientists, etc.

Why/in what way(s) have [these factors] discouraged them?

ARS Q4) How important is it that science is taught in schools to the age of 16?

1. Very important
2. Fairly important
3. Not very important
4. Not at all important.

7) Is learning science important for the individual and for society? Why? Why not?

Question prompts: to produce scientists that may make important discoveries in the future, to increase the prosperity of the nation, for medical/technological advances etc.

ARS Q5) How much do you agree or disagree with the following statement...In day-to-day life I rarely use the science learnt at school.

1. Strongly agree
2. Agree
3. Neither agree nor disagree
4. Disagree
5. Strongly disagree.

8) Is learning about science at school helpful or useful in your everyday life?

Question prompts: Is it relevant to their life out of school, to society in general? Can they provide any examples of when they have used something they have learnt through science at school in their everyday life, what made it useful?

9) Do you think that your science education is more or less useful for your life than other subjects you are studying at school?

Question prompts: Which subjects do they find more useful, what is it about a subject that makes it useful (compare to favourite subject as well as to other subjects)?

ARS Q6) How much do you agree or disagree with the following statement...Having a good understanding of science will improve a person's future career prospects, even if they don't go on to have a career in science.

1. Strongly agree
2. Agree
3. Neither agree nor disagree
4. Disagree
5. Strongly disagree.

10) Are you thinking about a science career?

Question prompts: What sort of job/career (e.g. any areas that may not be thought typical – engineering, health and beauty, hairdressing, cooking)? Do they think it is a well-paid or well-respected career? What sort of opportunities are there? Have they had any information about a science career, who from?

11) If you could change the science curriculum in any way you liked, what would you do?

Question prompts: What would they keep/remove/add? Are there any topic areas they would like to see included, or would have liked to have learnt about when they were younger at school (e.g. areas they thought would be interesting in primary school). Is it important that science in school relates to science out of school? Would this new curriculum encourage more students to take science options at school?

ARS Q7) How often do you visit places other than school to engage in science activities (e.g. museums, science centres, science festivals, zoos, discovery centres, nature reserves etc.)?

1. Once a week
2. A couple of times a month
3. Once a month
4. Less often than once a month
5. Never

12) At school, are you given many opportunities to do science-based activities outside the classroom – for example trips to zoos, museums or other places of interest?

Question prompts: What are these activities? How often are they available? Are they generally positive or negative experiences? Comparisons to classroom time? Helpfulness for learning?

[NB. For ARS questions 8–10, which follow, researcher to probe content with which the pupils are engaging, as well as motivations/influences for engagement, e.g. parents, friends, teacher etc.

ARS Q8) How often do you watch science programmes on TV (e.g. programmes about space, nature, medicine etc.)?

1. Every day
2. Several times a week
3. Once or twice a week
4. A couple of times a month
5. Once a month or less
6. Never.

ARS Q9) How often do you read about science topics in newspapers?

1. Every day
2. Several times a week
3. At least once a week
4. A couple of times a month
5. Once a month or less
6. Never.

ARS Q10) How often do you go on the internet to do activities relating to science? (e.g. to search the web for information, to use social networking sites, games sites on the web)

1. Every day
2. Several times a week
3. At least once a week
4. A couple of times a month
5. Once a month or less
6. Never.

A2.2 Questions used in interviews with pupils in school

A. Views on, and engagement in, science education

A1 Overall, how much do you enjoy studying at school?

Question prompt: Reasons for this?

A2 What is your favourite subject(s) at school

Question prompt: Why is that?

A3 Overall, how much do/did you enjoy studying science at school?

Question prompts: Find out levels of enjoyment of different science subjects (i.e. differences by subject). What would make it more enjoyable/interesting?

A4 Do/did you find learning science easy or difficult?

Question prompt: Why? What would make it easier for you?

A5 How does science compare to your favourite subject(s) at school? [*Rephrase if science is their favourite*]. What makes it different to other subjects? What makes it different to from English and/or history?

*Question prompts: Find out about **comparisons with other subjects** in terms of the classroom experience, the content (in terms of both knowledge and skills), the ways in which it is taught, the homework, opportunities to do things outside of the classroom etc.*

B. Influences on science education

B1. Has there been anything that has encouraged you personally to learn science?

Question prompts if needed: Enjoyment of subject, friends, teacher, practical work, relevance to real life, benefits for future study/career, parents' encouragement etc.

B2 Why and in what way(s) have [these factors] encouraged you?

Question prompts: Find out how they have been encouraged (e.g. perhaps towards specific subjects/career paths) – what is it about these factors that has encouraged them?

- B3. Has there been anything that has discouraged you personally from learning science?
Question prompts if needed: Level of difficulty, friends, poor teacher, no opportunity for practical work, lack of relevance to real life, no benefits for future study/career, too much written work/homework, negative image of science/scientists, too much repetition etc.
- B4. Why and in what way(s) have [these factors] discouraged you?
Question prompts: Find out how they have been discouraged (e.g. perhaps away from specific subjects/career paths) – what is it about these factors that has discouraged them?
- B5. Thinking about other people, what do you think are the things that might encourage or discourage people from learning science?
Question prompts: Enjoyment of subject, friends, teacher, practical work, relevance to real life, benefits for future study/career, parents' encouragement etc.

C. Science in society and science careers

- C1. Is it important for young people to learn science at school?
Question prompts: Why/why not? What is the purpose of science education, e.g. to give everyone some understanding of science, important for your career (whether you want a science career or not), important if you want to go to university?
- C2. Do you think learning about science at school is helpful or useful in your everyday life?
Question prompts: Usefulness to life out of school, to society in general (in terms of skills arising from science as well as scientific content). [Researcher to be aware of and draw on responses to B5 (what makes science different to other subjects) for this question.]
- C3. Can you think of a time when you have used something you have learnt through science at school in your everyday life?
Question prompts: Any pieces of information that have been used, any particular skills that have been useful? [Researcher to be aware of and draw on responses to B5 (what makes science different to other subjects) for this question.]
- C4. Do you think that your science education will be valuable for you in the future, for example, in everyday life or for getting a job?
Question prompts: What is it about science education that makes it useful (probe skills as well as content)?
- C5. Do you think that your science education is more, or less, useful for your life than other subjects you are studying at school?
Question prompts: Which subjects do they find more useful, what is it about a subject that makes it useful (compare to favourite subject as well as to other subjects)?

- C6 Have you ever considered, or are you considering, a science career?
Question prompts: What sort of job/career (e.g. any areas that may not be thought typical – engineering, health and beauty, hairdressing, cooking)? Do they think it is a well-paid or well-respected career? What sort of opportunities are there? Have they been given any information about a science career, who from?
- C7 Is further study in science or a science career something you would consider in the future?
Question prompts: Why/why not? What would make it more attractive for them to do so (e.g. better idea of jobs that are available, work experience, clear career progression routes)?
- C8 If you could change the science curriculum in any way you like, what would you do?
Question prompts: What would they keep, remove, add? Are there any topic areas they would like to see included, or would have liked to have learnt about when they were younger at school (e.g. areas they thought would be interesting in primary school)? Is it important that science in school relates to science out of school? Would this new curriculum encourage more students to take science options at school?
- C9 Do you think it is important for society that young people learn science at school?
Question prompts: Why/why not? To produce scientists that may make important discoveries in the future, to increase the prosperity of the nation, for medical/technological advances etc.

D. Science outside the classroom

- D1 At school, are you given many opportunities to do science-based activities outside the classroom – for example trips to zoos, museums or other places of interest?
Question prompts: What are these activities? How often are they available? Are they generally positive or negative experiences? Comparisons to classroom time? Helpfulness for learning?
- D2 How often do you think you read or see information about science – this could include seeing something on the television, the internet or in a newspaper, but could also be by visiting a zoo, science museum etc?
Question prompts: What information, how do they access it, why, with whom? Active versus passive acquisition of information.
- D3 Is there anything else you would like to add about your views on science that we haven't talked about?

A2.3 Questions used in interviews with young people out of education

A Views on, and engagement in, science education

- A1 Thinking back, overall, how much did you enjoy studying at school?
Question prompt: Reasons for this?
- A2 What was your favourite subject(s) at school?
Question prompt: Why was that?

- A3 Overall, how much did you enjoy studying science at school?
Question prompts: Find out levels of enjoyment of different science subjects (i.e. differences by subject). What would have made it more enjoyable/interesting?
- A4 Did you find learning science easy or difficult?
Question prompt: Why? What would have made it easier for you?
- A5 How did science compare to your favourite subject(s) at school? *[Rephrase if science is their favourite]*. What made it different to other subjects? What made it different to English and/or history?
*Question prompts: Find out about **comparisons with other subjects** in terms of the classroom experience, the content (in terms of both knowledge and skills), the ways in which it was taught, the homework, opportunities to do things outside of the classroom etc.*

B. Influences on science education

- B1. Was there anything that encouraged you personally to learn science?
Question prompts if needed: Enjoyment of subject, friends, teacher, practical work, relevance to real life, benefits for future study/career, parents' encouragement etc.
- B2 Why and in what way(s) did [these factors] encourage you?
Question prompts: Find out how were they encouraged (e.g. towards specific subjects/career paths) – what was it about these factors that encouraged them?
- B3. Was there anything that discouraged you personally from learning science?
Question prompts if needed: Level of difficulty, friends, family, poor teacher, no opportunity for practical work, lack of relevance to real life, no benefits for future study/career, too much written work/homework, negative image of science/scientists, too much repetition etc.
- B4 Why and in what way(s) did [these factors] discourage you?
Question prompts: Find out how were they discouraged (e.g. away from specific subjects/career paths) – what was it about these factors that discouraged them?
- B5 Thinking about other people, what do you think are the things that might encourage or discourage people from learning science?
Question prompts: Enjoyment of subject, friends, teacher, practical work, relevance to real life, benefits for future study/career, parents' encouragement etc.

C. Science in society and science careers

- C1 Is it important for young people to learn science at school?
Question prompts: Why/why not? What is the purpose of science education, e.g. to give everyone some understanding of science, important for your career (whether you want a science career or not), important if you want to go to university?
- C2 Do you think learning about science at school has been helpful or useful in your everyday life?
Question prompts: Usefulness to life out of school, to society in general (in terms of skills arising from science as well as scientific content). [Researcher to be aware of

and draw on responses to B5 (what makes science different to other subjects) for this question.]

- C3. Can you think of a time when you have used something you have learnt through science at school in your everyday life?
Question prompts: Any pieces of information that have been used, any particular skills that have been useful? [Researcher to be aware of and draw on responses to B5] (what makes science different to other subjects) for this question.]
- C4. Do you think that your science education will be valuable for you in the future, for example, in everyday life or for getting a job?
Question prompts: What is it about science education that makes it useful (probe skills as well as content)?
- C5. Do you think that your science education is more, or less, useful for your life than other subjects you studied at school?
Question prompts: Which subjects do they find more useful, what is it about a subject that makes it useful (compare to favourite subject as well as to other subjects)?
- C6. Did you ever consider a science career?
Question prompts: What sort of job/career (e.g. any areas that may not be thought typical – engineering, health and beauty, hairdressing, cooking)? Do they think it is a well-paid or well-respected career? What sort of opportunities are there? Were they given any information about a science career, who from?
- C7. Is further study in science or a science career something you would consider in the future?
Question prompts: Why/why not? What would make it more attractive for them to do so (e.g. better idea of jobs that are available, work experience, clear career progression routes)
- C8. Thinking back, if you could have changed the science curriculum in any way you liked, what would you have done?
Question prompts: What would they have kept/removed/added? Were there any topic areas they would have liked to have seen included, or would have liked to have learnt about when they were younger at school (e.g. areas they thought would be interesting in primary school)? Is it important that science in school relates to science out of school? Would this new curriculum encourage more students to take science options at school?
- C9. Do you think it is important for society that young people learn science at school?
Question prompts: Why/why not? To produce scientists that may make important discoveries in the future, to increase the prosperity of the nation, for medical/technological advances etc.

D. Science outside the classroom

- D1. When you were at school, were you given many opportunities to do science-based activities outside the classroom – for example trips to zoos, museums or other places of interest?

Question prompts: What were these activities? How often were they available? Were they generally positive or negative experiences? Comparisons to classroom time? Helpfulness for learning?

D2 Now that you are no longer at school, how often do you think you read or see information about science – this could include seeing something on the television, the internet or in a newspaper, but could also be by visiting a zoo, science museum etc.?
Question prompts: What information, how do they access it, why, with whom? Active versus passive acquisition of information.

D3 Is there anything else you would like to add about your views on science that we haven't talked about?

This work is © the Wellcome Trust and is licensed under Creative Commons Attribution 2.0 UK.

The future of science depends on the quality of science education today.

We are a global charitable foundation dedicated to achieving extraordinary improvements in human and animal health. We support the brightest minds in biomedical research and the medical humanities. Our breadth of support includes public engagement, education and the application of research to improve health. We are independent of both political and commercial interests.

Wellcome Trust
Gibbs Building
215 Euston Road
London NW1 2BE, UK
T +44 (0)20 7611 8888
F +44 (0)20 7611 8545
E education@wellcome.ac.uk
www.wellcome.ac.uk

The Wellcome Trust is a charity registered in England and Wales, no. 210183. Its sole trustee is The Wellcome Trust Limited, a company registered in England and Wales, no. 2711000 (whose registered office is at 215 Euston Road, London NW1 2BE, UK). PE-5265/09-2011/AF