Subject Choice in STEM: Factors Influencing Young People (aged 14–19) in Education

A systematic review of the UK literature

October 2010

EPPI Centre

wellcome trust

Evidence for Policy and Practice
Information and Co-ordinating Centre

The EPPI-Centre is part of the Social Science Research Unit, Institute of Education, University of London

Factors Influencing Young People (Aged 14-19) in Education about STEM Subject Choices: A systematic review of the UK literature

PREFACE

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Conflicts of interest

There are no conflicts of interest for any members of the review team.

ISBN 978-1-84129-087-4

Acknowledgements

This review was commissioned by the Wellcome Trust.

The review team would like to thank members of the Advisory Group for their contributions, including Hannah Russell (Wellcome Trust), Hannah Baker (Wellcome Trust), Derek Bell (Wellcome Trust), Peter Stagg (Centre for Education and Industry at the University of Warwick) and Cathy Bereznicki (Performing Arts Labs).

Table of contents

Foreword

Subject Choice in STEM: More questions than answers

Derek Bell

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Introduction

Everyone has to make choices at different stages in their life. Some of the most crucial relate to their education, in particular what combination of subjects they decide to take for higher-level study. For most young people such choices take place between the ages of 14 and 18. In England they are likely to be asked to make selections at 14, when they decide which GCSE courses they are to pursue, at 16 when they select their post-16 studies and then at 18 in deciding on higher or further education programmes or their chosen area of employment.

As important as these choices are for individuals, such decisions also have wider economic implications for the country. This is particularly the case with STEM (science, technology, engineering and mathematics) subjects. Major government-funded inquiries (e.g. Roberts, 2002; Smith, 2004) identified a mismatch between skills acquired during formal education and those required in the workplace. This phenomenon is not unique to the UK, with many OECD countries facing similar difficulties in terms of student participation in STEM (OECD Global Science Forum, 2006).

In common with other countries the UK government is committed to fostering STEM-related innovation in the UK. The Science and Innovation Investment Framework 2004-2014 (HM Treasury, 2004; 2006) set out priorities for addressing skills shortages. Improving education in the STEM subjects was identified as a key element, leading to the STEM Programme that was launched in October 2006. This provides a strategic framework through which support for STEM subjects in schools and colleges is made more effective and more accessible (DfES, 2006). A key premise underpinning many of the proposals is the view that young people begin to make choices about careers early in their education.

Helping young people to make the most appropriate subject choices is therefore crucial, both to ensure that the country has the skills its needs for the economy and to enable young people to make the best choices to meet their own future needs and aspirations.

Aim of the review

Against this background, the Wellcome Trust commissioned the Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI-Centre) to undertake a systematic review to examine why young people make the subject choices they do. The review specifically addressed the question: 'What factors influence the STEM subject choices of young people (aged 14-19) in education in the UK?'

Outcomes of the review

The most striking outcome of this review has been to highlight the underlying challenges faced in building research capacity. Student choice is a significantly under-investigated area. Even where research exists, the lack of resources and expertise severely limits the extent to which the findings can be relied upon to provide a robust evidence base for action.

For the purposes of this review, 25 studies met the criteria to be included for in-depth analysis but only 12 were judged to be of medium to high overall quality. Synthesis of the studies was hampered because although some of the studies included considerable amounts of data, only a small proportion of this dealt specifically with subject choice. The wide range of factors considered by the different investigations further reduced the potential for reliable synthesis of the available evidence.

Reflection on the outcomes of the review emphasises the many challenges - small sample sizes, short-term 'snapshot' approaches, inconsistent analysis, imprecise terminology and overreliance on historical (pre-2000) data - that have to be overcome to produce the high-quality research overview needed to provide reliable conclusions from which policy and practice can be developed.

The findings of this work illustrate the urgent need to build a reliable evidence base that better informs why young people make the subject choices they do. Some larger-scale studies are already underway, such as those commissioned under the Economic and Social Research Council's targeted initiative on science and mathematics education. There are also opportunities for building capacity in this area, including the exploitation of the large datasets, such as the National Pupil Database, which have been established and lend themselves to cohort studies of young people as they move through their education.

Building capacity in this area is essential as robust research evidence is important not only to ensure that the right skills are available to support the future economic wellbeing of the country but also to better advise the young people themselves.

Summary of the review

The review was designed in two stages to address the following overarching questions:

1. What is the nature and extent of the research that has been undertaken in OECD countries on the factors that influence young people (aged 11-19) in education, or their parents, in relation to subject choices?

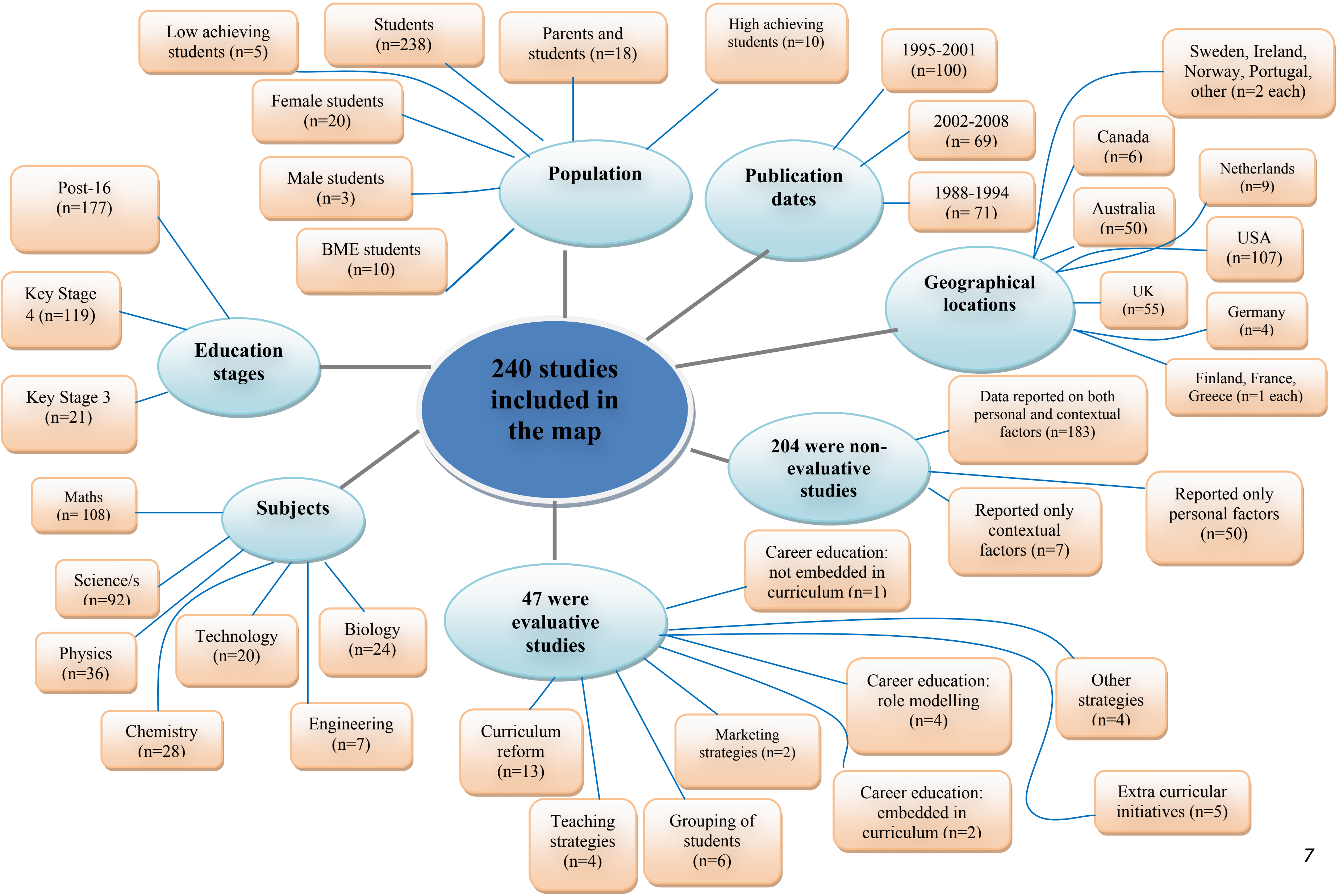
2. What factors influence the STEM subject choices of young people (aged 14-19) in education in the UK?

In doing so, the review was intended to:

- produce a systematic map describing the nature and extent of research investigating factors influencing young people in education (11-19 years) or their parents in relation to subject choices
- provide an in-depth analysis of the factors influencing the STEM subject choices of young people (14-19 years) in the UK
- consider implications from the review in terms of research, policy and practice.

Factors influencing subject choice: a map of research activity
Figure A below presents an overview of studies undertaken in OECD countries on the factors that influence young people (aged 11-19) in education, or their parents, in relation to subject choices.

Figure A: Map of research activity



Of 7235 potentially relevant citations, 240 studies were identified as meeting the criteria for inclusion in the map. The majority had a major focus on at least one STEM subject, ranging from 108 that included mathematics to seven that referred specifically to engineering. This contrasted with those investigating non-STEM subjects, of which modern foreign languages (37 studies) was the most prominent.

Pupils' views about their future (117 studies) were most frequently explored, followed by gender (107) and the school context (93). Of particular relevance to the current review, pupils' views about STEM subjects were part of over 30 per cent (88) of the studies.

This level of interest in STEM subjects in these studies reflects the particular economic interest shown in STEM and wider concerns about potential skills shortages (as noted above).

STEM subject choices of young people (14-19): in-depth review

The factors that have been considered to influence subject choice are listed below - but, with the exception of gender, ethnicity and ability, each factor was only investigated in one study and/or in lower-quality studies:

- gender
- ethnicity
- ability
- socioeconomic status
- school/college size
- school type (comprehensive/grammar/etc.)
- school type (with sixth-form/without sixth-form)
- school type (single-sex/co-educational)
- school type (independent/local authority)
- school type (religious denomination)
- grouping practices (i.e. setting by ability)
- geographical setting
- subjects taken at GCSE
- qualifications of teaching staff
- performance of school/college
- school status (degree of autonomy of school management)
- gender ratio of staff
- urbanicity.

Only 12 studies were identified as medium to high quality. The following findings are based on these studies only.

Gender: In common with two previous reviews (Pollard, 2003; Murphy and Whitelegg, 2006), the analysis showed that boys and girls tend to make different choices. The data indicate that around age 14, boys are more likely to take separate sciences than girls are, when given the choice. In contrast, girls were more likely than boys to take modern foreign languages.

Ethnicity: Although the review indicates that young people described as Asian are more likely than those from other ethnic groups to select science and/or mathematics subjects post-16, the data have to be treated with caution. The studies in question treat this category as a homogenous group, yet it encompasses people coming from different socio-cultural and ethnic backgrounds. This observation emphasises the complex nature of the problem and the significant challenges to researchers in trying to understand the main drivers of subject choice for young people.

Ability: Young people with higher levels of prior attainment are more likely than those with lower levels of prior attainment to continue their studies in science and/or mathematics subjects. This finding reinforces that of Gorard and See (2008b) in their review exploring the relationship between socioeconomic status and participation and attainment in science.

The perceived usefulness of the subject for personal reasons, such as further studies or future careers, was a major reason young people gave for their choice of subjects for post-16 study, the other main reasons being their assessment of their own ability in the subject and level of enjoyment/interest. Girls were more likely than boys to refer to interest and enjoyment as a reason, while boys were more likely than girls to talk about how easy they considered the subject to be.

Overall conclusion

The review has resulted in some interesting findings but ultimately it has raised many more questions than it answered. Without doubt, the most significant finding was the lack of good-quality research on this topic - a situation that should be addressed.

Chapter 1. Background

1.1 Outline of chapter

This chapter outlines the background to the review (section 1.2), the aims of the review (section 1.3), and the review questions (section 1.4).

1.2 Introduction

1.2.1 Policy and practice background

In the twenty-first century, a population well-educated in science and technology is essential not only for the longer term competitiveness of the economy, but for the health and welfare of society as a whole. Recent research, including major UK Government-funded inquiries, has identified potentially serious skill shortages in these fields, with a mismatch between skills acquired during formal education and those required in the workplace that could adversely affect the Government's productivity and innovation strategy (Roberts, 2002; Smith, 2004). This situation is not unique to the UK, with many OECD countries facing similar difficulties in terms of student participation in STEM subjects (OECD Global Science Forum, 2006).

Having identified STEM as a national priority, the Government's commitment to fostering STEM-related innovation in the UK and meeting the long-term needs/demands of the STEM sector is set out in the Science and Innovation Investment Framework 2004-2014 (HM Treasury, 2004; 2006) and the 2006 Budget. The Department for Children, Schools and Families (DCSF)[1] has taken a major lead in developing a better delivery system for STEM initiatives and activities. For example, as part of the STEM Programme launched in October 2006, a new strategic framework was proposed through which STEM support across all phases of education would be made more effective and more accessible (DfES, 2006).

There has also been increasing recognition that young people require more understanding and support when making decisions about subject selection. One of the central beliefs underpinning a number of recent reforms is the view that young people begin to make choices early. In 2004, in recognition of this need to provide young people with timely advice and support, the then DfES extended the duty on maintained schools in England and Wales to deliver a curriculum-based programme of careers education to students in Years 7 and 8, to enable young people to develop career management skills earlier, so they are better prepared to take their first set of decisions during Year 9 (Key Stage 4 options). The 14-19 Education and Skills White Paper published in March 2005 outlined further curriculum and qualifications reforms, at the heart of which was the entitlement of all young people to choose personalised pathways which suit them and which form a strong basis for their progression (DfES, 2005).

1.2.2 Research background

There have been a number of reviews relevant to the issue of STEM subject choice, including those by Gorard and See (2008b), Haynes (2008), Moon et al. (2004),

[1] And its predecessor, the Department for Education and Skills (DfES).

McCrone et al. (2005), Murphy and Whitelegg (2006), Osborne et al. (1996), Osborne et al. (2003), Roger and Duffield (2000) and Pollard et al. (2003). For a number of reasons, the identified reviews are limited in relation to their relevance to evidence-informed UK policy and practice decision-making. Firstly, whilst a number of the previous reviews discussed the quality of the evidence base, only one formally and systematically appraised the quality of reviewed studies and incorporated any weighting of this quality into its analysis (Moon et al., 2004). Secondly, although the topic has been the subject of considerable exploration, none of these reviews has research questions identical to that stipulated by the funding organisation (see 1.3 and 1.4 below). For example, Osborne et al. (2003) sought to provide a review of the many facets of research on students' attitudes to science; Pollard et al. (2003) focused on subject and career choices (often not distinguishing between the two). Several previous reviews were not STEM-specific (e.g. McCrone et al., 2005; Moon et al., 2004) and most either focused on one stage of education only or did not differentiate between stages. None focused on the relevant UK literature alone. The current review of the evidence base was commissioned in order to address, as far as possible, some of these limitations, thereby contributing to the accumulative literature in this field and a greater understanding of the complex issues involved.

1.3 Aims of the review

The Evidence for Policy and Practice Information and Coordinating Centre (EPPI-Centre) was commissioned by the Wellcome Trust to undertake a systematic review of research about subject choice. The main aim of the review was to examine the factors that influence the STEM subject choices of young people (14-19 years) in education in the UK. The findings from the review will feed into the Wellcome Trust's own education programme and contribute to discussion and initiatives, including further research, in the science, technology, engineering and mathematics (STEM) education community more broadly.

1.4 Review questions

The systematic review was carried out in two stages: Stage 1, a mapping exercise, followed by Stage 2, an in-depth review focusing on a sub-set of the mapped studies. More detail on each of these stages is provided in Chapter 2. Each stage of the review addressed a key research question. The broad question answered by the first stage (map) was:

What is the nature and extent of the research that has been undertaken in OECD countries on the factors that influence young people (aged 11-19) in education, or their parents, in relation to subject choices?

This was broken down into two inter-related sub-questions which helped to further define the field of enquiry.

What is the nature and extent of the non-evaluative research that has been undertaken in OECD countries on the factors that influence young people (aged 11-19) in education, or their parents, in relation to subject choices?

What is the nature and extent of the evaluative research that has been undertaken in OECD countries on interventions to encourage particular subject choices?

Based on the findings of the systematic map, a more narrowly focused in-depth review question was developed in consultation with the review funder. This question was:

What factors influence the STEM subject choices of young people (aged 14-19) in education in the UK?

1.5 Educational context

Terms such as 'science' and 'technology' are used to mean a range of things, depending on the context in which they are used and by whom. In order to provide some explanation of the use of such terms, an overview of the UK education system follows. This brief summary also outlines other key terminology used in the review (such as Key Stages).

The National Curriculum framework was introduced in 1989 in England, Wales and Northern Ireland to provide children with a structured and balanced education during the period of compulsory schooling. It is organised into blocks of years called Key Stages:

- Key Stage 1: 5-7 years old (Years 1 and 2)
- Key Stage 2: 7-11 years old (Years 3 to 6)
- Key Stage 3: 11-14 years old (Years 7 to 9)
- Key Stage 4: 14-16 years old (Years 10 and 11)

There is also a notional Key Stage 5, an unofficial label used to describe the two years of post-compulsory education (16-19 years), also referred to as 'post-16'.

Scotland has its own curriculum framework that is separate from that in England, Wales and Northern Ireland. In Scotland, the education system is not based around Key Stages, secondary school starts a year later, at age 12, and there are only four years of compulsory secondary schooling (see Table 1.1). The systems are similar in that compulsory schooling ends at approximately 16 years of age and national school-leaving examinations are taken at this time.

Assessment at Key Stage 4 in England, Wales and Northern Ireland is by means of the General Certificate of Secondary Education (GCSE). In Scotland, pupils in S3 and S4 (14-16 years) study subjects at Standard Grade (Scottish Certification of Education). In England, Wales and Northern Ireland, academic courses post-16 lead to the General Certificate of Education Advanced level (GCE A-level). Advanced Subsidiary (AS) courses are also available, equal in weight to half an A-level. In Scotland, the main post-16 academic qualification is the Higher Grade.

Table 1.1: UK school system year groupings[2]

Age	England & Wales	Northern Ireland	Scotland
11-12	Secondary Key Stage 3 Year 7	Secondary Key Stage 3 Year 7	
12-13	Year 8	Year 8	Secondary S1
13-14	Year 9	Year 9	S2
14-15	Secondary Key Stage 4 Year 10	Secondary Key Stage 4 Year 10	S3
15-16	Year 11	Year 11	S4
END OF COMPULSORY SCHOOLING			
16-17	Year 12 (lower sixth)	Year 12	S5
17-18	Year 13 (upper sixth)	Year 13	S6

Science is a core subject in the National Curriculum, together with English and mathematics, and it is studied by pupils at all Key Stages (5-16 years).[3] A broad range of other subjects are mandatory until the end of Key Stage 3 (age 14). In science, pupils of all ages are required to study a balance of biology, physics and chemistry (with some aspects of earth science and astronomy). In the last 20 years there have been many changes that have influenced the science education of students in compulsory education. Until relatively recently (i.e. during the majority of the period covered by this review) there were three GCSE science courses available to Key Stage 4 students: Double Award Science, Single Award Science and Triple Award Science. *Single Award Science* refers to a GCSE syllabus where a pupil studied the three sciences of biology, chemistry and physics as one combined subject, resulting in a single GCSE. *Double Award Science* involved the combined study of biology, chemistry and physics, resulting in two GCSEs. *Triple Award Science* is shorthand for separate GCSEs in biology, chemistry and physics. In 2006, the Education and Inspections Act replaced 'double award' science and introduced a new statutory entitlement for Key Stage 4 pupils to have access to a course of study leading to either (i) a GCSE in core science *and* a further GCSE in 'additional science' or 'applied science', or (ii) *all three* GCSEs in physics, chemistry and biology. Clearly, although choice of GCSE science has been limited since the introduction of the National Curriculum, pupils do have some choice as to what to study. In design and technology (mandatory only until the age of 14) there are a number of different options open to interested students. Courses that can be taken to obtain a GCSE qualification in this subject include food technology, graphic products, resistant materials technology and textiles technology. For both science and technology at GCSE level, the extent of student 'choice' will also depend on the range of subjects offered by individual schools.

In Scotland, a curriculum framework was introduced in secondary schools in 1983, comprising choice of subjects within compulsory 'modes of study' (including 'scientific studies and applications' and 'technological activities and applications'). For pupils aged 5-14, the curriculum is fairly similar to other areas of the UK. Pupils aged 14-16 years typically take eight subjects, including compulsory examinations in English, mathematics, a science subject, a social subject and a foreign language. For science, students choose one or more of the following subjects: physics, chemistry, biology or general science. 'Technological activities and applications' covers a range of subjects that provide a more technical and vocational education. Students choose from a

[2] Ages for each year group are approximate as a school year is defined differently in the separate systems.
[3] Welsh is a core subject in Welsh-speaking schools.

number of subjects, including craft and design, graphic communication and technological studies. As in other parts of the UK, it would appear that Scottish 14-16 year old pupils also have some choices in relation to the study of science and technology; again, however, the individual circumstances of schools attended by pupils are likely to place additional limits on student 'choice'.

- GCSE subject choices are made at the end of Key Stage 3 and young people select the A-levels that they wish to study at the end of Key Stage 4. However, in this report 'Key Stage 4 subject choices' (and similar phrases) should be read as subjects selected for GCSE (or equivalent) study.
- Key Stage 4 has been used throughout the report as shorthand for the period of education when students study for national school leaving examinations (i.e. when they are 14-16 years old). For ease of reporting, it has occasionally been used in references to the equivalent period in Scotland – i.e. the third and fourth years of secondary school (S3 and S4).
- In this report, no distinction has been made between AS and A-level (and generally only the latter has been used).

Chapter 2. Methods used in the review

2.1 Outline of chapter

This chapter describes the methods used in the systematic review, including the steps taken to minimise bias in the review process and assure quality of the final product. An outline of the type of review is detailed in section 2.2, followed by information on user involvement (section 2.3), methods used in the mapping stage (section 2.4) and those used to undertake the in-depth review (section 2.5).

2.2 Type of review

The review was conducted in two stages using the standard procedures and processes developed by the EPPI-Centre.

The first stage (mapping) consisted of identifying and describing all studies that met the review inclusion criteria. Descriptive information about these studies was collected and presented in the form of a 'map' of research in the field of factors influencing students' subject choices. Maps are a useful product in their own right and create a database of studies that facilitate sustainability and the potential for development of a cumulative knowledge base. They highlight strengths and gaps in the research base and can therefore be used to indicate possible areas for further research. They also provide a basis for informed discussion and decision making between the review team and review users about the focus of the second stage in-depth review.

At the second, in-depth stage of the review, a more detailed investigation of a focused subset of the wider literature was undertaken. This involved a synthesis of the findings of selected studies, in order to provide answers to the in-depth review question.

2.3 User involvement

An advisory group was set up to inform the scope and development of the review, and to increase its relevance for policy. Group membership consisted of researchers from the EPPI-Centre and the Wellcome Trust. Additional expert input was provided between the first and second stage of the review by Peter Stagg (Centre for Education and Industry at the University of Warwick) and Cathy Bereznicki (Performing Arts Labs).

2.4 Mapping stage methods

2.4.1 Defining relevant studies: inclusion and exclusion criteria

In a systematic review, selection criteria are used to identify the relevant studies. For this review, these criteria were developed and agreed with the Wellcome Trust. An initial set (see Table 2.1) defined the boundaries of the map.

Studies published prior to the establishment of the National Curriculum (1988 Education Reform Act) were outside the scope of the map, as the subject choice process underwent substantial revision following its implementation. The map was limited to studies conducted in OECD countries[4], as they are more similar to the UK than are non-OECD countries in the goals/organisation of their educational systems. Further details about the scope of the map, including the rationale underlying other key decisions, are provided in Appendix B.

An intervention study is defined as a study that aims to evaluate or measure the impact of an intervention (an intervention being a set of mechanisms, actions or techniques aiming to influence target outcomes). Non-intervention research refers to studies that aim to observe, describe, or understand phenomena. Put another way, the purpose of intervention studies is to determine '*what works'* and non-intervention studies describe *what is happening* and *why.* For the purposes of this review, the terms 'intervention study' and 'evaluative study/research' were used interchangeably, as were 'non-intervention study' and 'non-evaluative study/research'.

[4] Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States.

Table 2.1 Selection criteria (Stage 1: mapping)

Inclusion Criteria	Exclusion Criteria
1. Complete citation	1. Incomplete citation
2. Published in English	2. Not published in English
3. Published in or after 1988	3. Published before 1988
4. Is primary empirical research	4. Is, for example, an editorial, commentary, book review, policy document, resource, textbook, manual, guidelines, bibliography, theoretical paper, position/opinion paper, or a review (non-systematic review or systematic review)
5. Contains data relating to young people in education aged 11-19 years	5. Does not contain data relating to young people in education aged 11-19 years
6. Is a study providing non-evaluative research evidence on the influence of factors (for example, gender, peers, type of school attended, attitudes) on decision-making in relation to subject choices	6. Is a study providing non-evaluative research evidence that is not about the influence of factors on decision-making in relation to subject choices
7. Is a study providing non-evaluative research evidence, either (i) in the form of an analysis of reasons cited by participants as influencing their subject choices, or (ii) methods have been used to establish a statistical relationship between variables (e.g. gender, school type, attitudes) and subject choices	7. Is a descriptive study of enrolment patterns or trends
8. Is a study evaluating an intervention, and either (a) the intervention aimed to influence students' decision-making in relation to subject choices, or (b) an outcome measured by the study was students' subject choices (planned or actual)	8. Is a study evaluating an intervention and the intervention did not aim to influence students' decision-making in relation to subject choices, nor did the study measure students' subject choices (planned or actual)
9. Is a study evaluating an intervention of the types relevant to this review (all relevant except initial teacher training)	9. Is a study evaluating initial teacher training
10. Conducted in an OECD country	10. Not conducted in an OECD country

2.4.2 Identification of potential studies: search strategy

A sensitive search strategy was developed using the review questions, the conceptual framework and the selection criteria that defined the studies being looked for. Further details of the search strategy are given in Appendix A. To locate as much literature as possible, a range of sources was used:

- Electronic bibliographic databases;
- Websites of organisations known to have an interest in this area;
- Search engines (Google and Google Scholar);
- Citation checking of key reviews in this area;
- Contact with researchers who have undertaken work in this area.

The search terms (or key words) were developed iteratively using a combination of techniques:

- Free text terms and relevant index terms were identified (both synonyms and antonyms) which could be used to describe the important concepts (students, parents, subject choices);
- Pilot searches were undertaken to test the identified terms, which were then refined and used to search the bibliographic databases.

Searches covered the period 1988 to 2008 and were conducted during the first week of October 2008. Citations identified in the above searches were imported into EPPI-Reviewer, the EPPI-Centre's specialist web-based systematic reviewing software (Thomas and Brunton, 2006).

Additional attempts to locate relevant studies involved the use of snow-ball searching, using studies identified during the screening process which described, but did not evaluate, relevant interventions.

2.4.3 Identifying relevant studies: applying inclusion and exclusion criteria

The inclusion and exclusion criteria (Table 2.1) were applied successively to the titles and abstracts of papers identified using the search strategy. Full reports were obtained for those studies that appeared to meet the criteria or where there was insufficient information to be sure. The inclusion and exclusion criteria were then re-applied to the full reports and those that did not meet the criteria were excluded. Decisions on the relevance of the study were based upon examination of the titles, key words, abstracts, and, where necessary, the complete text to ensure that all relevant studies were included.

2.4.4 Characterising included studies

The first level of coding for all studies remaining after application of the selection criteria provides data for the purposes of describing, or mapping, the overall field of research on the topic area. The included studies were data extracted (or coded) using standardised EPPI-Centre coding frameworks and coding questions developed specifically for this review. The coding tool was developed in conjunction with the Wellcome Trust (see Appendix C). Both contextual and methodological information were collected, focusing on areas of interest to the review.

2.4.5 Quality assurance process

The mapping stage of the review followed standard EPPI-Centre procedures for maintaining quality. The search strategy was developed iteratively and tested using studies identified through handsearching. At the screening stage of the review process, the titles and abstracts of a sub-sample of studies were screened independently by all the team members. The results were shared and discussed, in order to ensure consistency of application of the inclusion criteria. The same quality assurance process was followed at the data extraction (coding) stage.

2.5 In-depth review methods

2.5.1 Moving from broad characterisation (mapping) to in-depth review

The focused question for the in-depth review was agreed in consultation with the Wellcome Trust and with additional expert input (section 2.3). Decisions took account of the findings of the map, policy priorities and the resources and time available to complete the review. To identify relevant studies for inclusion in the in-depth review, a second set of selection criteria was developed from the in-depth review question and applied to the 240 studies in the map (see Table 2.2).

Table 2.2: Selection criteria (Stage 2: in-depth review)

Inclusion criteria	Exclusion criteria
11. Is a non-evaluative study on the factors influencing students' subject choices	11. Is an evaluative study investigating the impact of an intervention to influence students' subject choices
12. Conducted in the UK	12. Not conducted in the UK
13. Findings are STEM-specific	13. Findings not STEM-specific
14. Data post-1988	14. Data pre-1988

2.5.2 Detailed description of studies in the in-depth review

The data extraction that was undertaken provided detailed information about each study – in effect, the raw data for analysis and synthesis. During the data extraction process, the contents of each paper were summarised and evaluated according to pre-agreed categories. This provided further information about study context, study results for synthesis, and information on which to base judgments about the quality, trustworthiness and relevance of the study to the review. Detailed data was extracted about, for example, characteristics of the participants/samples, factors associated with young people's subject choices, and design features relating to the quality of the included studies (e.g. statistical methods). Detailed descriptions of the studies included in the in-depth review are presented in Chapter 5 (with further details in Appendix E).

2.5.3 Assessing study quality and weight of evidence for the review question

The quality of each included study was assessed using the EPPI–Centre's weight of evidence (WoE) framework. This framework has four components:

- WoE A: The soundness of the studies, based upon the study only. This component focuses on the overall methodological quality of the study. Studies were rated into five categories (high, high/medium, medium, low/medium, or low) based on the extent to which the study findings can be trusted and whether conclusions were logically drawn from the results. This takes into account the quality of sampling strategies, risk of bias, reliability and validity of data collection and analyses, quality of reporting and generalisability or transferability of findings.

- WoE B: The appropriateness of the research design and type of analysis used for answering the review question. Studies were rated into three categories (high, medium, or low), which, reflecting the review question, were largely based on the potential of the design and analysis to predict causal relationships.

High: regression analysis;
Medium: correlational analysis, ANOVA;
Low: any other type of statistical test to establish group differences (for example, chi-square), descriptive data analyses (where findings are presented as percentages, means, etc), and qualitative analyses.

- WoE C: The relevance of the focus of the study to the review question (in terms of characteristics of the sample, such as nationality, or other indicators of the focus of the study). In this review, all studies were rated high.

- WOE D: An overall weight of evidence, taking into account A, B, and C, and using a pre-established formula for moving from A, B and C to D. In this review, an average of A, B and C was used, with D not greater than A.

2.5.4 Synthesis of evidence

The data was synthesised to bring together the studies which answered the in-depth review question. The methods of synthesis used reflected the types of studies included in the in-depth review, and the detail and quality of reporting in these studies. Although a number of studies used statistical analysis approaches based on the General Linear Model, meta-regression was not thought to be applicable as it was felt to be misleading to suggest that coefficients are directly comparable across different regression models, different populations and different outcome measures. For this reason, specific coefficients have not been used or reported as part of the synthesis. Any differences between coefficients are as likely to be due to differences in datasets or methods of analysis, as they are indicative of any true underlying difference in the phenomenon being examined. The relevant coefficients for each study can be found in Appendix E.

Most study authors referred to statistical significance levels in their interpretation of the data. There are a number of limitations of this approach, both generally and specifically to its use in this review. Statistical significance is an estimate of the likelihood of a particular result occurring by chance. Statistical significance is linked to sample size and the probability of a study being able to detect an ‘effect’ of a given magnitude. The absence of a statistically significant ‘effect’ does not necessarily indicate that there is no ‘effect’, but may simply be the result of the sample being too small to detect an ‘effect’ at the given significance level (by convention $p = 0.05$). For this reason, in this review the synthesis considered all relevant results, regardless of whether they had reached statistical significance or not. All relevant results have been reported in Chapter 6, however only those reaching a level of statistical significance of 5 per cent (or a more stringent level) have been indicated as being statistically significant.

Following an approach that has been used in previous reviews (for example, Newman et al., 2006), a conceptual framework was developed that enabled a narrative thematic synthesis of the studies. This was based on the broad approaches taken by the studies to the review question: either statistical analyses of socio-demographic/school-level factors, or analyses of students’ personal reasons for choosing to study a particular subject. Two different approaches to synthesis were taken within these two categories.

Studies within the first category were grouped by variable (factor) investigated. Summary tables were constructed showing the direction of 'effect' as more likely, or less likely, on the particular variable (e.g. girls more likely than boys). The synthesis then focused on searching for patterns of similarity or difference in the direction of 'effects'. The most obvious reasons for any differences in the 'effects' found by the primary studies are the different ways in which independent and dependent variables have been constructed, differences in the variables that have been entered into the regression models and the extent to which the studies have dealt with threats to their validity.

Within the second category (reasons), studies used a variety of approaches and methods to derive students' motives for studying a particular subject or not. The variation in methods used meant that only limited synthesis of the results from each individual study was possible. The synthesis focused primarily on identification of the main reasons identified in each individual study and compared these across studies.

No interpretation was undertaken, or conclusions drawn, when a result was based only on lower quality studies (i.e. those rated low or low/medium overall weight of evidence). For studies designed to establish statistical relationships between variables, all findings from medium and medium/high studies had to point to the same conclusion in order to increase our confidence that a relationship between subject choice and the investigated factor existed.

2.5.5. In-depth review: quality assurance process

Each study in the in-depth review was independently data-extracted by two reviewers. Comparative reports were discussed until any discrepancies were reconciled. This process was undertaken in order to develop and check consistency of data-extraction and quality assessment judgements between members of the review team. Selecting different combinations of reviewers (of whom there were five in total) was also used to maintain consistency. Synthesis interpretation and report writing involved all members of the review team in a process of iteration, checking and discussion.

Chapter 3. Search and selection results

3.1 Flow of literature through the map

Figure 3.1 illustrates the flow of literature through each stage of the map. The searches identified a total of 7235 records. Of these, 7196 citations were identified through systematic searches of electronic bibliographic databases. A further 39 papers were identified through website searches and citation checking of relevant reviews.

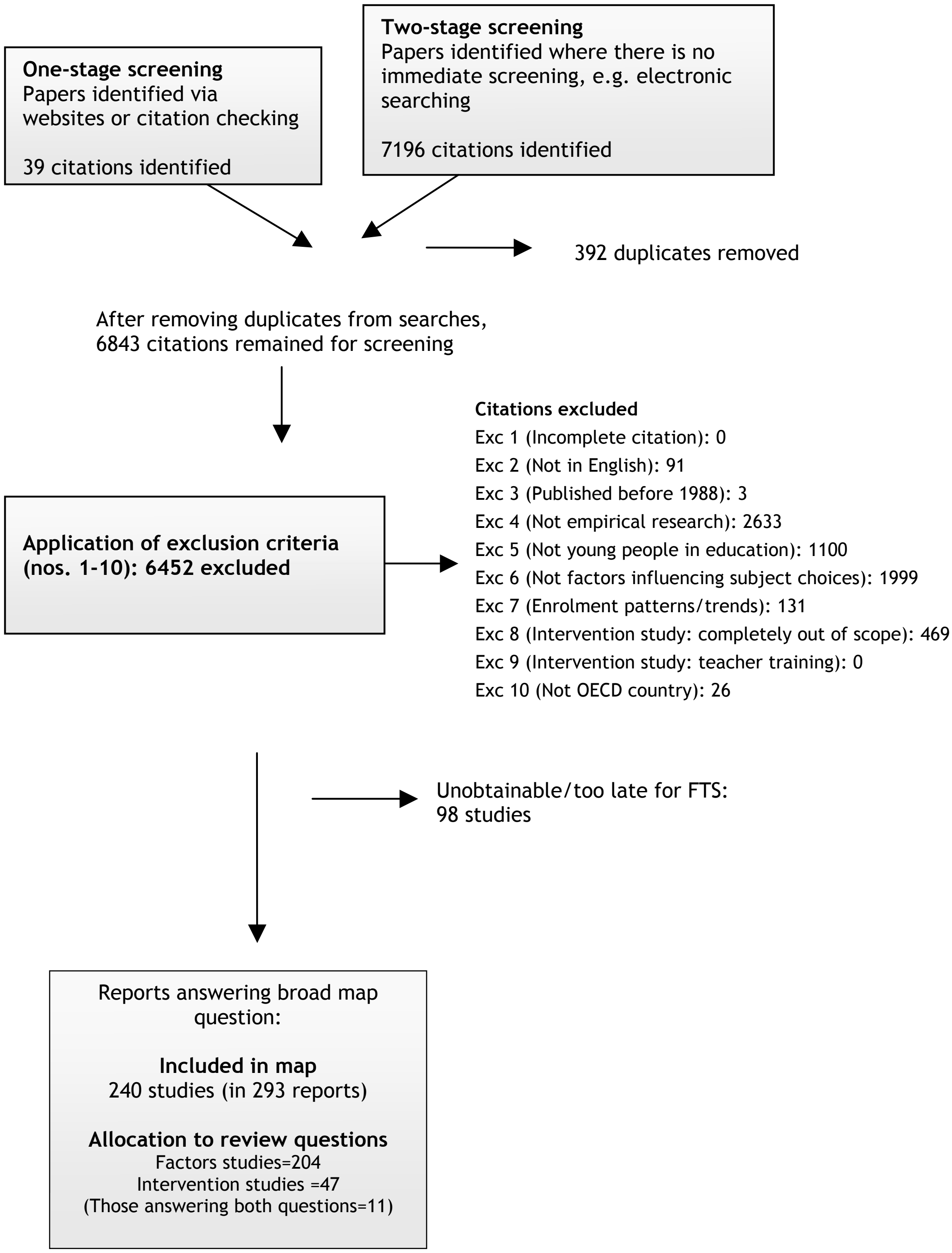
A total of 392 citations were identified as duplicates and were removed from the review process. The titles and abstracts of the remaining 6843 records were screened against the inclusion/exclusion criteria. Full-text reports were obtained for those studies that appeared to meet the criteria or where there was insufficient information to be sure. In total, 98 studies either were identified as unavailable or arrived too late for the map.

A total of 240 available studies (in 293 reports) were identified as answering the overall broad review question:

What is the nature and extent of the research that has been undertaken in OECD countries on the factors that influence young people (aged 11-19) in education, or their parents, in relation to subject choices?

Reflecting the two sub-questions, the systematic map identified and characterised studies of two main kinds. A total of 204 studies addressed the first sub-question: *what is the nature and extent of the non-evaluative research that has been undertaken in OECD countries on the factors that influence young people (aged 11-19) in education, or their parents, in relation to subject choices?* Also included in the map were 47 intervention studies addressing the second sub-question: *what is the nature and extent of the evaluative research that has been undertaken in OECD countries on interventions to encourage particular subject choices?* These groups are not mutually exclusive; 11 studies provided both non-evaluative and evaluative evidence (i.e. the study addressed both sub-questions by conducting more than one relevant analysis).

Figure 3.1 Selection of studies



Chapter 4. Identifying and describing studies: map results

4.1 Overview

This chapter presents the results of the mapping exercise. The map set out to answer the broad question:

What is the nature and extent of the research that has been undertaken in OECD countries on the factors that influence young people (aged 11-19) in education, or their parents, in relation to subject choices?

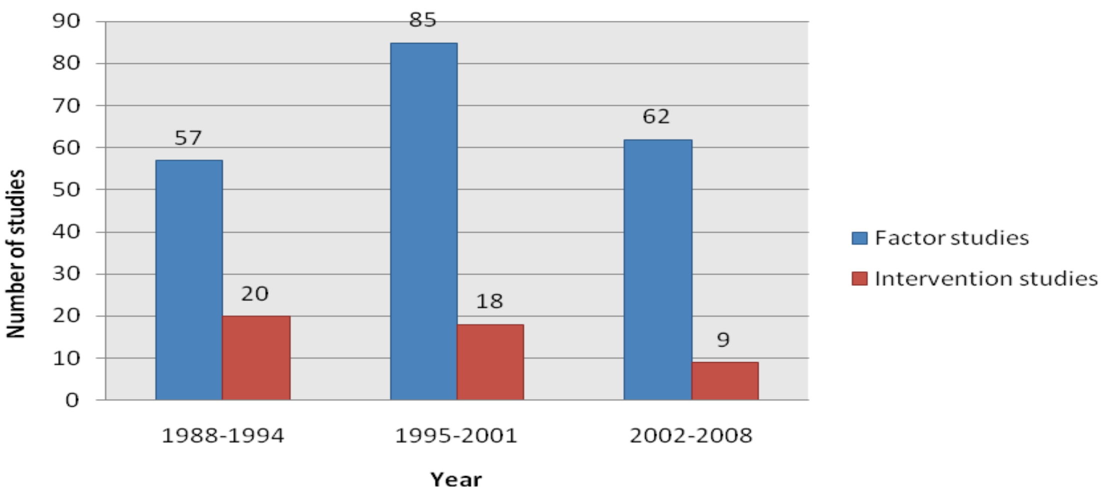
A total of 240 available studies were identified as answering this question (204 non-intervention studies; 47 intervention studies). The following description of the included literature is based on the data that was extracted with the coding tool and provides contextual and methodological information about selected aspects of the studies. Some of the findings are reported separately for the different types of study in the map (factors and intervention studies). Information is presented as follows: when the studies were published (4.2.1); where the studies were conducted (4.2.2); characteristics of the study population (4.2.3); stage of education that students' decision-making related to (4.2.4); subject focus (4.2.5); factors investigated in the non-intervention studies (4.2.6); intervention types (4.2.7); and outcomes measured in the intervention studies (4.2.8).

4.2 Characteristics of the included studies in the systematic map

4.2.1 When were the studies published?

The scope of the map extended to relevant studies published 1988 onwards. The 240 identified studies were not evenly distributed throughout the period of interest. The number of publications was at its greatest during the period 1995 to 2001. Figure 4.1 illustrates the publication dates for both types of studies in the map (factors and intervention studies).

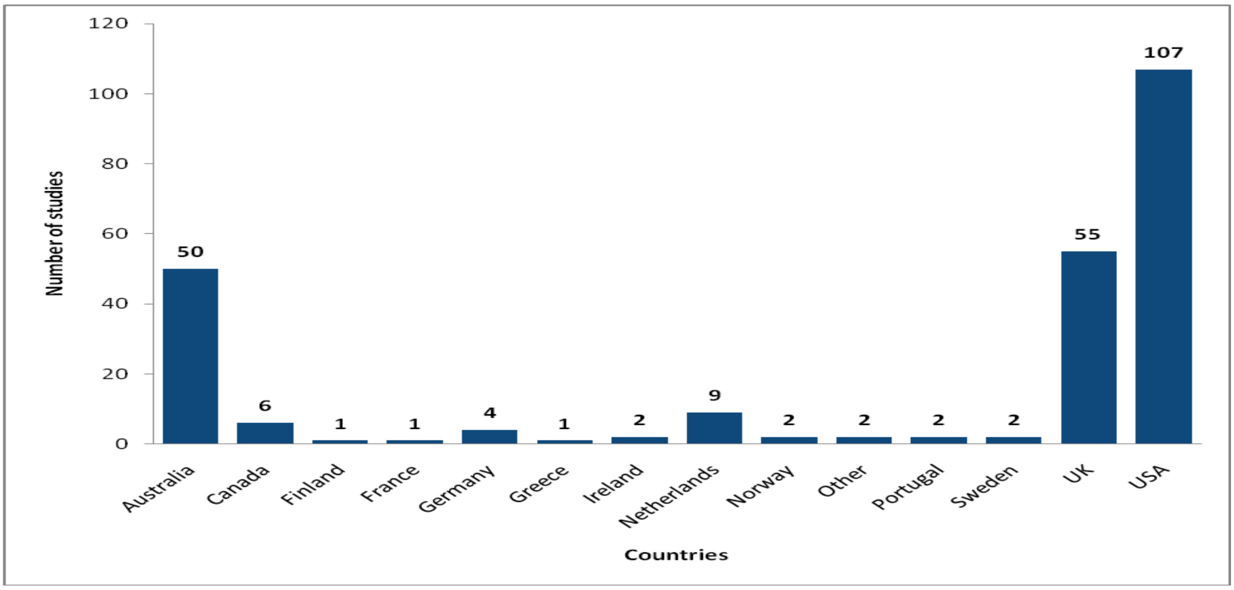
Figure 4.1 Publication dates for the studies



4.2.2 Where were the studies conducted?

The scope restricted included studies to those conducted in OECD countries. As Figure 4.2 illustrates, the majority of studies were carried out in three countries, with just under half conducted in the USA (107 studies), around a quarter (55 studies) conducted in the UK and about one-fifth in Australia (50 studies). Four studies were cross-national comparison studies. Of these, one study used data from Germany and the USA, one study compared Finland and Norway, one study compared France and Portugal and the fourth study focused on the USA and a non-OECD country, Taiwan. A further one study was conducted across 59 northern hemisphere countries, many of which were OECD countries.

Figure 4.2 Geographical locations of studies



4.2.3 Who were the study population?

The majority of studies included students among the participants (n=238). Some studies also included parents, teachers or other adult stakeholders. More than 30 studies investigated the views that teachers or other school staff had about influences on young people's subject choices. Eighteen studies included parents in the study population, but none focused exclusively on parents.

The majority of studies included mixed-sex populations (n=215). Only a small minority of studies focused on single-sex populations. Twenty studies were focused solely on female students and three studies on male students only.

A minority of studies were focused on particular subgroups of students. Ten studies were specifically concerned with black/minority ethnic students, in a further ten studies the attention was on high achieving (gifted/talented) students, and in five studies low achieving/at risk students were the target population.

4.2.4 Stage of education

As part of the coding of studies, attempts were made to distinguish between the different stages of education that students' decision-making related to. The inclusion of international literature in the review meant that it was necessary to accommodate the different education systems that have been adopted by OECD countries. Some non-UK countries, for example Australia, have systems that are broadly similar to those in the UK. Others differ in key aspects, most notably the United States (US). In the US, although compulsory education likewise usually ends at age 16, the system is slightly different in that there are no recognised qualifications issued to students who do not complete secondary education through to the 12th year (when students are usually aged 18 years). For the purposes of the review, the Key Stage system operating in England, Northern Ireland and Wales was used to group studies (for further details, see section 1.5). Other educational systems were 'matched' to these stages, based on the ages (or year group) of the students participating in the studies. A distinction was therefore made between choices relating to:

- pre-examination subjects (11-14 years: Key Stage 3)
- school-leaving examination subjects (14-16 years: Key Stage 4)
- post-compulsory examination subjects (post-16: Key Stage 5).

Details of the stages of education that the students' decision-making related to are presented in Table 4.1, by type of study. The three categories are discrete (i.e. studies of 14 year olds would be coded as either KS3 or KS4, but not both). However, where studies focused on more than one age group of pupil, more than one 'stage of education' would be selected. A number of studies did not specify the year group that outcomes related to. Where, for example, it was only reported that the decision-making related to US high school subject choices, both Key Stage 4 and post-16 were selected.

Table 4.1: Stage of education that decision-making related to, by type of study

Stage of education	Factors studies* (n)	Intervention studies* (n)	All studies* (n)
Key Stage 3 (11-14 years)	19	3	21
Key Stage 4 (14-16 years)	98	27	119
Post-16 (Key Stage 5)	145	38	177
Not stated/unclear	8	1	9

*Not mutually exclusive

4.2.5 What subjects did the studies focus on?

Table 4.2 illustrates the subject focus of the studies included in the map, by study type and overall. In the majority of studies, the key concern was one or more STEM subjects (particularly mathematics and/or science subjects), in some cases alongside other subjects. In 20 studies overall, the investigation of students' decision-making was not subject-specific (coded 'none'). A relatively high number of studies focused on subjects coded as 'other': subjects in this category included, for example, economics, media studies, 'arts' and 'humanities-oriented' subjects. The majority of studies focused on more than one subject/subject area.

Table 4.2: Subject focus of studies

Subjects	Factors Studies* (n)	Intervention Studies* (n)	All studies* (n)
STEM subjects			
Mathematics	89	25	108
Science/s	70	28	92
Physics	31	8	36
Chemistry	21	9	28
Biology	19	6	24
Technology	16	6	20
Engineering	5	2	7
Non-STEM subjects			
Modern Foreign Languages	31	8	37
Geography	13	2	14
ICT	13	3	14
English	18	8	24
History	13	3	15
Art	14	6	19
Physical Education	8	4	11
Business Studies	4	0	4
Drama	3	0	3
Music	5	2	7
Dance	2	0	3
Geology	1	0	1
Psychology	1	1	1
Religious Education	2	2	4
Other	34	8	39
None	16	4	20

* Not mutually exclusive

4.2.6 What factors did the studies investigate?

Non-evaluative 'factors' studies included in the systematic map investigated a wide range of personal and contextual factors that may influence students' subject decisions. More than half the studies in the map (n=147) explored both personal and contextual factors (with 50 studies having reported only personal factors and nine studies contextual factors only). The purpose of the mapping stage was restricted to highlighting the factors that were investigated in the primary studies; no findings were extracted and there was no attempt to code details about the complex relationships between personal and contextual factors.

Personal factors

The majority of studies (n=197) reported one or more personal factors influencing students' subject choices, as illustrated in Table 4.3. There is some overlap between some of the categories that were used to group the factors reported in the studies. For example, a student's concerns about their grade point average (GPA) could be viewed as concern about their future educational goals. The approach used in the review was to select the category listed in the coding tool that was the 'best fit' for each factor mentioned in the study report; i.e. only one category was selected for each reported factor. More detailed categories were used where appropriate, but the more general categories (such as 'views about subjects') may have grouped together factors that have notable differences between them. Most studies reported more than one personal factor.

Table 4.3: Personal factors

Personal factors	No. of studies*
Pupils' views about the future (e.g. educational/career-related goals)	117
Pupils' views about STEM subjects (e.g. interest, enjoyment, perceived difficulty of subject	88
Views about non-STEM subjects	65
Pupils' self-concept (e.g. pupils' views about their own ability, their identity)	64
Pupils' views about subjects' appropriateness (e.g. by gender, by ability)	17
Pupils' views about image/legitimacy/hierarchy of subjects	6
Pupils' prior experiences of learning the subject	27
Ability/educational attainment	77
Family socio-economic status (SES)	49
Ethnicity	31
Gender	107
Pupils' prior knowledge of the subject	12
Cultural influences (e.g. views about family heritage)	2
Grade point average (GPA) concerns	8
Student does not have necessary course pre-requisites	4
Cognitive preferences	6
Health/disability	2
Other	24
None	7

*Not mutually exclusive

Contextual factors

A broad range of contextual factors were identified in a total of 154 studies, some of which are illustrated in Table 4.4. Most studies reported more than one contextual factor.

Table 4.4: Contextual factors

Contextual factors	No. of studies*
School-level factors (e.g. school type, timetabling constraints)	93
Family influences (e.g. sex-stereotyped attitudes about careers or practical advice/encouragement)	73
Teachers/other school staff influences	66
Peer influences	52
Careers education/guidance	23
Other	22
Teaching strategies	11
National or regional level factors	9
SES (neighbourhood/school)	7
Media	5
Labour market	2
None	50

* Not mutually exclusive

4.2.7 What types of intervention did the studies evaluate?

A total of 47 intervention studies were identified. A limited examination of the interventions was conducted and they have been grouped into nine categories. For the purposes of this map, the categories in Table 4.5 are mutually exclusive. Two studies evaluated two different types of intervention.

Table 4.5: Intervention types

Intervention type	No. of studies*
Curriculum reform	13
Teaching/pedagogic strategies	4
Grouping of students (by sex, by ability)	6
Career education/guidance (embedded in the curriculum)	2
Career education/guidance (not embedded in the curriculum)	1
Career education/guidance (using role modelling)	4
Extra-curricular activities (supplementary education)	3
Marketing strategies	2
Multi-component	5
Other	4

* Not mutually exclusive

Curriculum reform

The majority of the interventions involving reform of the curriculum were educational policies applied at the regional or national level. Three distinct themes emerged: compulsion, choice, relevance.

- Compulsion: Several of the evaluated curriculum reforms involved legislation that made certain subjects compulsory, particularly mathematics and science; in other words, these interventions removed choice. Included in the map are evaluations of: (i) the National Curriculum (England and Wales) (Bell, 2001; Brown, 2001); (ii) the introduction of a common core curriculum after 1983 in Scotland (Croxford, 1994); (iii) the US Regents Action Plan and various US state reforms that increased graduation requirements (Alexander, 2002; Catterall and Moody, 1990; Clune, 1991; Goertz, 1989; Hanson, 1989; Tuma and Gifford, 1990); and (iv) the Australian Unit Curriculum (Johnston et al., 1993; Rennie and Parker, 1993).
- Choice: This group of curriculum interventions (all UK) sought to give students greater breadth and choice; for example, the 'double award' science qualification, Curriculum 2000, and the more recent 2004 curriculum specifications (Bell et al., 2006; Sears, 1992; Matthews and Pepper, 2007).
- Relevance: One evaluation focused exclusively on the impact of subject–specific curricular redesign. The University of Chicago School Mathematics Project changed the curriculum content in order to make mathematics more relevant for a greater number of students (Hirschhorn, 1996).

Teaching/pedagogic strategies

Four studies evaluated the impact on subject choice of teaching/pedagogic strategies designed to enhance student learning through, for example, the development and provision of new instructional materials (Kahle, 1989), different approaches to teaching involving the use of games and student-centred activities (Marsh, 1995), advanced classes to high-achieving students (Kjellman, 2005), or the integration of technology into instruction to meet the needs of established curricula (Woodrow et al., 2000).

Grouping strategies

In a total of six studies, two different forms of grouping practices were evaluated. Five studies evaluated the impact of single-sex teaching in co-educational schools (Crombie, 1999; Gillibrand et al., 1999; Shapka and Keating, 2003; Wood and Brown, 1997; Parker and Rennie, 1995). One study evaluated the impact of a track placement policy involving the grouping of students by ability (Zuniga et al., 2005).

Career education/guidance (embedded in curriculum)

One study evaluated a career education/guidance initiative which was embedded in the curriculum. Mathematics and science career awareness was infused into the mathematics and science curricula, as well as other subjects (Fouad, 1995).

Career education/guidance (not embedded in curriculum)

A further two studies evaluated school-based career education/guidance interventions that were not delivered as part of the curriculum. Both interventions were explicitly concerned with developing educational/occupational knowledge and guiding students in relation to their subject choices. In one, there was a focus on involving both parents and students in the educational and career planning process (Peterson et al., 1999; Wentworth et al., 1998).

Career development based around role modelling

Four studies evaluated three different interventions that used the role modelling approach to career education and guidance. In these programmes, individuals from university departments and/or local industries encourage students to pursue careers in their particular fields, through, for example, attempts at breaking down sex-stereotyped views or helping students select the correct subjects to follow a STEM-related career choice. The interventions in this category were the Women in Science and Engineering (WISE) project (Brown, 1995), the Expanding Your Horizons Conference (Conwell and Prichard, 1992; Hecht and Hecht, 1996) and the Engineering Link Project (Millican et al., 2005).

Supplementary education (i.e. extra-curricular opportunities)

In four studies, the interventions provided opportunities for students to engage in more exciting, hands-on research activities than those normally available at school. The impact of participation in these extra-curricular activities (typically, summer schools) on subsequent choice of subjects taken at school was measured. The interventions in this category were the Newton Summer Academy (Ellis-Kalton, 2002), the George Engelmann Mathematics and Science Institute's Science Scholar Programme (Granger and Mares, 1993), the Siemens Science Experience (Jane and Peeler, 2006) and the Summer Programme at the Bowman Gray School of Medicine (Watts et al., 1989).

Marketing strategies
Two studies evaluated marketing initiatives that were focused on recruitment. Both sought to educate students about the nature/content of different courses, and how to enrol, etc. Activities included classroom visits and guided tours, the development of enrolment instruction booklets, and instruction of instructing faculty and student leaders on how to identify and enrol potential students (Wilson, 1989; Ahlborn, 1995).

Multi-component strategies
Six studies were evaluations of multi-component interventions involving the use of different approaches within a single programme. Single-sex grouping, marketing/recruitment techniques, role modelling and additional (i.e. afterschool or weekend) classes were among the strategies used by the different projects. The interventions in this category were the Gateway to Higher Education initiative (Campbell et al., 1998), the Girls into Science and Technology (GIST) project (Kelly, 1995), the Comprehensive Partnership for Mathematics and Science Achievement (Kim and Crasco, 2003), the Urban Project (Mulkey and Ellis, 1990), the Technical Education Demonstration Program (Milwaukee Area Technical College, 1992) and an un-named initiative (Maehrlein, 1993).

'Other' interventions
Five studies evaluated interventions that did not fit into any of the above categories. One study evaluated the impact on student course-taking behaviour of the no pass/no play rule enacted in Texas (Ligon, 1988). Under this rule, a student must pass every course or sit out extracurricular activities in the following six-week grading period. In two studies, the impact (within education) of the 1975 Sex Discrimination Act was examined (Brown, 2001; Croxford, 1994). Two studies conducted experiments guided by the theory of planned behaviour (TPB) and elaboration likelihood model (ELM) to assess the effectiveness of different types of belief-based information: in-class or take-home materials based on students' beliefs about enrolling for subjects (Black and Crawley, 1991; Crawley and Koballa, 1992).

4.2.8 What outcomes were reported?

All 47 intervention studies measured student outcomes (see Table 4.6). A range of relevant outcomes were identified. In this review, the two outcomes that were of particular interest (actual or planned subject choices) were pre-specified as the main outcomes. In total, 46 studies measured actual and/or intended subject choices. The scope of the map extended to evaluations of interventions designed to influence subject choice decisions but where other outcomes, such as changes in attitudes to subjects, had been measured. One study measured 'other' outcomes only (Millican et al., 2005). Many studies measured more than one outcome, therefore the number of studies in the right-hand column of Table 4.6 is greater than the number of intervention studies (n=47).

Table 4.6: Outcomes measured by intervention studies

Main outcomes	No. of studies*
Actual subject choices	42
Planned/intended subject choices	6
None	1
Other outcomes	
Knowledge about subjects/courses	1
Attitudes to subject choices	9
Achievement/effort	17
Career choices	5
Career knowledge	3
Educational choices not related to subject choice	8
Self-esteem/confidence	3
Other	5
None	20

*Not mutually exclusive

Chapter 5. In-depth review: overview of studies

5.1 Overview

This chapter describes the selection of studies for in-depth review (section 5.2) and the characteristics of the included studies (sections 5.3 and 5.4). Further details about the studies are presented in Appendices D and E.

5.2 Selecting studies for the in-depth review

The 240 studies included in the map were screened for inclusion in the in-depth review, using selection criteria specifically developed for the second stage of the review. Table 5.1 outlines how many studies were excluded from the in-depth review on each additional criterion.

Table 5.1 Studies excluded from the in-depth review

Exclusion no.	11: Evaluative study	12: Not UK	13: Not STEM	14: Pre-1988 data
No. of studies excluded	36	153	25	5

The references of the 21 studies that remained were checked for additional relevant studies, and a further three studies were identified as answering the in-depth review question. Additional linked reports (i.e. other publications of the same study) were also identified during this process. A further study included in the in-depth review was one that had been identified during the mapping exercise as being relevant, but the report had been unavailable at that time.[5] In total, 25 studies (in 46 reports) were included in the in-depth review.

5.3 Characterising the studies included in the in-depth review

A feature of the research included in the in-depth review is its methodological diversity. A number of studies analysed data collected for other purposes by other researchers. Of these, three used large-scale national datasets: the England and Wales Youth Cohort Study, the Scottish Young People’s Survey, and the secondary national value-added dataset (NVAD). In those studies not using secondary data, data were collected using questionnaire surveys, individual interviews and/or focus groups. Although some studies involved longitudinal data collection, the majority of analyses that are relevant to this review were cross-sectional in design (i.e. were based on data collected at one point in time only).

All the studies were published between 1990 and 2008. Seventeen studies analysed data from England and/or Wales. Of these, 13 focused exclusively on England and a further two studies were conducted in Wales only. Three studies were based in Scotland, and four in Northern Ireland. In one study, the case study schools were located throughout the United Kingdom.

[5] Several potentially relevant studies remained unavailable throughout the review process.

Eight studies investigated the factors influencing young people's Key Stage 4 (or equivalent) subject choices. Twenty studies produced evidence in relation to post-16 subject choices. (Three studies focused on both Key Stage 4 and Key Stage 5 choices.) In all, four studies conducted interviews with teachers and/or other educational stakeholders, two of which sought the views of school staff on the factors influencing students' subject decisions. The findings from these two studies contribute to the review.

The Weight of Evidence (WoE) judgements made about each study are shown in Table 5.2. A number of studies included in the in-depth review used more than one method of analysis. In four such studies, the analyses have been separately weighted to reflect the two different approaches taken by studies to the in-depth review question; i.e. statistical analyses seeking to establish relationships between various variables and take-up of subjects, and explorations of students' reasons for selecting/not selecting subjects (discussed in further detail in Chapter 6). Five studies (or sub-studies) were judged to be medium/high overall WoE, nine were rated medium WoE, four rated low/medium WoE and 11 rated low overall.

Table 5.2 Weight of evidence (WoE) of studies included in the in-depth review

	WoE A Trustworthiness of study findings	WoE B Appropriateness of study design	WoE C Relevance of study focus to review	WoE D Overall weight of evidence
Bewick & Southern (1997)	low	low	high	low
Brown et al. (2008)* - statistical analysis of 'factors' - 'reasons'	 medium medium/high	 medium low	 high high	 medium medium
Cheng et al. (1995)	medium/high	high	high	medium/high
Cleaves (2005)	medium	low	high	medium
Croxford (1994)	medium/high	high	high	medium/high
Curry et al. (1994)	low	low	high	low
Darling & Glendinning (1996)	low	low	high	low
Gallagher et al. (1996)* - statistical analysis of 'factors' - 'reasons'	 low/medium medium	 low low	 high high	 low/medium medium
Gillibrand et al. (1999)	low/medium	low	high	low/medium
Havard (1996)	low	low	high	low
Hendley et al. (1996)	low	low	high	low
Jarman et al. (1998)	low/medium	low	high	low/medium
Johnson (1999)	medium/high	medium	high	medium/high
Matthews & Pepper (2007)	medium/high	low	high	medium
McCarthy & Moss (1990)	low	low	high	low
Mendick (2006)	medium	low	high	medium
Munro & Elsom (2000)	medium	low	high	medium
Reid & Skryabina (2002)	low	low	high	low
Sears (1997)	low	low	high	low
Sharp et al. (1996)* - statistical analysis of 'factors' - 'reasons'	 low/medium low	 low low	 high high	 low/medium low
Spielhofer et al. (2002)	medium/high	high	high	medium/high
Springate et al. (2008)	medium	low	high	medium
Tebbutt (1993)	low	low	high	low
Vidal Rodeiro (2007)*				

- statistical analysis of 'factors' - 'reasons'	medium/high medium/high	high low	high high	medium/high medium
Wikeley & Stables (1999)	low	low	high	low

*Study used more than one method of analysis and they have been weighted separately.

5.4 Study summaries

The remainder of this chapter presents summaries of all studies. They are presented in alphabetical order. The topic/aim of each study is described, together with brief details of the method(s) used. Details of the study results are given in Appendix E.

Bewick and Southern (1997) Factors influencing students' choice of mathematics at A-level

Topic: This study investigated the main reasons for pupils' choice of A-level mathematics and the relationship between gender and A-level choices.

Data and research methods: This research was based on a questionnaire sent to A-level students, 1005 of whom responded (response rate 59.2 per cent). The 198 students who indicated that they had chosen to study mathematics were the focus of this study. The research was set in Brighton and Hove, England. A range of institutions took part: four maintained (11-18) schools, two sixth-form colleges, one independent mixed school and two independent girls' schools. Questionnaires were issued to every student in the first year of the sixth form who was studying one or more A-levels. Each student was asked to identify the main reason for each choice of A-level subject. The possible responses were: good grades at GCSE, influenced by teacher or other adult, relevant to your intended career, particular interest, and other. A frequency analysis was carried out and a chi-square test used to determine whether any gender differences that were found were statistically significant.

Brown et al. (2008) I would rather die: reasons given by 16-year-olds for not continuing their study of mathematics

Topic: The broad aim of this research was to see whether a large-scale data set provided any useful insights into students' motives for discontinuing with mathematics at age 16.

Data and research methods: Two different analyses used in this study produced findings that are relevant to the in-depth review. The research used a dataset from a broader study in which one of the authors was involved (Stobart et al., 2005). Data were collected using a four-page questionnaire (based on both free-response and closed items) given to students immediately after they had taken their GCSE examinations and before they had received the results. The current research was based on answers given by the students to a small part of the questionnaire that was not analysed as part of the broader study. A wide range of schools was sampled, with respect to their geographical spread across England and Wales and their size range. There was one single-sex (boys') school and two faith schools. The sample of 17 schools (over 1500 pupils in total) was somewhat above average in terms of overall attainment. The first relevant analysis considered the reasons students gave for not continuing with mathematics. These were coded iteratively and grouped into what appeared to be the major distinct themes. The data were analysed by predicted grade and by gender for individual students. The proportion of the sample citing each category of reason was reported. Illustrative quotes from student responses selected as the most able to typify categories of reasons were also presented. The second relevant analysis attempted to identify whether some schools in the sample were more effective than others in attracting students to participate in A-level mathematics, and, if so, whether the data provided any clues as to why the differences between schools might occur. For each school, four indices were calculated (relating respectively to 'like', 'enjoy', 'anxious' and 'easy') that indicated student attitudes towards mathematics and which were independent of the distribution of predicted attainment of students in mathematics within each school. The research then correlated indices across schools (using the Pearson's Product Moment Coefficient) to see if there was any relation between the index indicating choice of attitude words and the index relating to students intended continued participation with mathematics.

Cheng et al. (1995) The England and Wales Youth Cohort Study: science and mathematics in full-time education after 16

Topic: The purpose of this research was to explore the structure of subject choices made by young people who continue in full-time education after 16 and the influences upon them. The focus was on physical sciences, life sciences and mathematics. To be included in the physical sciences group students had either to be taking two physical science A-levels (defined as chemistry, physics, physical sciences, geology) or at least one physical science plus mathematics. Students were included in the life sciences group if they took at least one life sciences subject (biology, botany, zoology), and included in the mathematics group if they took at least one mathematics subject (pure and applied mathematics, statistics, arithmetic, computer science).

Data and research methods: This research was based on data from the England and Wales Youth Cohort Study (YCS) which tracks large nationally representative samples of young people over the first few years after compulsory schooling, through a series of postal questionnaires sent out at yearly intervals. A series of multivariate models were fitted to the data, using multi-level modelling techniques (logistic regression and multi-level modelling). The statistical models used YCS Cohort 5 data: 14,511 students who were first surveyed in the spring of 1991. The researchers obtained additional information about the schools that cohort members attended up to age 16. As these additional school data were only available for state schools in England, the models excluded students who, in Year 11, attended independent and/or Welsh schools. In the models, predictor variables were divided into two groups: individual-level variables and school-level variables. Individual-level predictor variables were of two kinds: personal/family characteristics, and Year 11 GCSE results. Personal and family characteristics included sex, ethnic origin and parental occupation/educational qualifications/employment status. At the school level, five variables pertaining to the schools attended in the GCSE year were examined: school status, balance of A-level courses, qualifications of the teaching staff, experience of the teaching staff, and the gender ratio amongst the teaching staff. The analyses were based on young people who were studying for at least two A-levels at the time of the survey.

Cleaves (2005) The formation of science choices in secondary school

Topic: This study examined the formation of post-16 choices over three years among higher achieving students in relation to enrolment in post-compulsory science courses.

Data and research method: The study was carried out in four waves on students from six mixed comprehensive schools in England. The 72 above-average academic achievement students were interviewed during their last three years in secondary school. Semi-structured interviews were carried out with 12 students. The first interviews were conducted when students were, on average, 13 years old, and examined their ideas about school subjects in relation to influences, interests and preferences. Subsequent interviews were held at the end of Year 9, Year 10 and Year 11. The authors used the themes derived from an analysis of each set of interviews to inform questions for subsequent interviews. Data collection and analysis were based on grounded theory. All data were analysed from all interviews to allow exploration of data both transversally across the sample and longitudinally over time. Discourse analysis was also carried out to capture changes in students' thoughts and ideas on subject choice.

Croxford (1994) Equal opportunities in the secondary-school curriculum in Scotland, 1977-91

Topic: This study sought to explore the extent of equal opportunities in the curriculum through an analysis of differences in participation in the formal curriculum by social class, gender, measured ability and school type. A key aim of the study was to reveal the effects of the 1975 Sex Discrimination Act and the introduction (in 1983) of a common core curriculum in Scotland on the subjects studied by pupils in their final two years of compulsory schooling (S4 stage). There are findings in relation to five 'modes of study': modern languages, scientific studies, technological activities, social and environmental studies and creative and aesthetic studies.

Data and research methods: National data from the Scottish Young People's Survey (SYPS), 1977-1991, was used to explore factors influencing subject choice. The SYPS was a biennial postal questionnaire survey of quasi-random samples of young people in Scotland, and focused on the final two years of compulsory schooling when pupils are between the ages of 15 and 16. The sample sizes for each year of the survey used in this study were: 1985 (n=6426), 1987 (n=6323), 1989 (n=5501) and 1991 (n=4401). The effects of social class, gender, measured ability, school type and time (and the interactions between these factors) was measured with the aid of a statistical model (logistic regression). The focus was on the probability of studying at least one subject in a particular 'mode of study'.

Curry et al. (1994) The effect of life domains on girls' possible selves

Topic: The study adopted the role of 'possible selves' to identify 'careerist', 'adaptive' and 'home centred' work orientation among the sample. Differences between these groups were investigated in terms of subject choice, attainment and attitudes towards career and family.

Data and research methods: The study was part of the Longitudinal Assessment of Mathematical beliefs, Development and Attainment (LAMDA) project. The sample (240 girls and 280 boys) comprised sixth-form pupils taking A-level subjects in grammar schools within Northern Ireland; however, the research reported in this paper focused on girls only. Two different data collection methods were used: questionnaire and group discussions. Only evidence derived from the questionnaire is relevant to this review. The study identified an aspect of work orientation (careerists, adaptive, home centred) by categorising responses from the questionnaire (e.g. those who chose 'working full-time for most of my married life' were classified as careerist). Data from the questionnaire was analysed using the chi-square test.

Darling and Glendinning (1996) Patterns of subject choice: a local study

Topic: This study explored Scottish pupils' experiences in secondary school and involved an examination of student achievement, subject choice and career intention. The focus was on a wide range of subjects (16 in total) within the Standard Grade curriculum (equivalent to KS4), including science, biology, chemistry, physics and technology (craft and design). The research was set within the context of a broader study which considered theory, history and social context in an exploration of the debate about gender issues in schools.

Data and research methods: The research used data from the Grampian Equal Opportunities study, for which a total of 483 pupils (drawn from seven secondary schools from across the Grampian region of Scotland) were surveyed. The schools were purposively chosen to represent a variety of settings within a geographically diverse area covering most of the north-east of Scotland. Participants were third- and fourth-year students from the selected schools. They were asked to indicate who had been a major influence on their subject choices (self, parents or teachers). This was undertaken solely with pupils who were studying the subjects at the time of the survey. A frequency analysis was conducted and the findings presented separately for boys and girls (as percentages).

Gallagher et al. (1996) Girls and A level science 1985 to 1995

Topic: This research was a ten-year follow-up to research conducted in the mid-1980s. Therefore, an overarching aim was to examine the consequences of changes in educational policy. More specifically, the aims of the research were to examine evidence on the uptake of science/mathematics A-levels subjects and on attainment. There was a key focus on girls.

Data and research methods: A questionnaire sample of 1600 lower sixth-form grammar school pupils was drawn from 21 schools selected to reflect the demographic profile of Northern Ireland (728 boys, 872 girls). The sample represented 17.1 per cent of the total population of pupils in year 12 attending grammar schools during the academic year 1994/5. A higher than average proportion of those studied had fathers employed in non-manual occupations. Ten of the sample schools were requested to provide pupils for focus group discussions (80 pupils in total). Using questionnaire data, the role of a number of variables (e.g. religion, type of school attended) on the average number of science/mathematics A-levels taken by the pupils in the study was investigated. The second relevant analysis was based on questionnaire questions which asked students to rate, in order of importance and on a score from 1 to 3, a number of different reasons for choosing their A-level subjects. Mean scores were reported for each reason. For both of these analyses, tests were carried out to determine whether differences between groups were statistically significant. The third relevant analysis was based on qualitative data collected through focus groups. It was reported that these data were collected to help explain the findings identified through the questionnaire. The interviews were recorded on audio tape and later transcribed into text. Students were asked about their reasons for choosing their A-level subjects.

Gillibrand et al. (1999) Girls' participation in physics in single sex classes in mixed schools in relation to confidence and achievement

Topic: The broad aim of the study was to examine relationships between single-sex teaching and girls' confidence, achievement and further study of physics. In seeking to explain how the intervention (single-sex teaching) was successful, the study investigated whether girls who reported increased confidence over the period of study would be more likely to proceed to A-level physics.

Data and research methods: This research was a three-year longitudinal case study of two single-sex GCSE physics classes in a mixed comprehensive school serving a small town and its proximal rural communities in the South West of England. The pupils attending the school come from fairly homogeneous socioeconomic and socio-cultural backgrounds. The sample was 58 girls who were studying GCSE physics at the higher level, and who generally had aspirations for further and higher education. There were five components of assessment, two of which relate to the findings that are relevant to the in-depth review: (1) a questionnaire measure of girls' confidence in learning and using physics; (2) school records of the numbers choosing to study physics at A-level. The relationship between final confidence scores and choosing to do A-level physics (for cohorts 1 and 2 combined) was examined. The results of a frequency analysis indicated the numbers of girls choosing physics for each of three levels of confidence. A chi-square test was carried out to determine whether any differences between the groups that were found were statistically significant.

Havard (1996) Student attitudes to studying A-level sciences

Topic: This study investigated sixth-form students' attitudes to the study of science at A-level, and the factors that influenced the students in deciding whether to take those subjects.

Data and research methods: A purposive sampling strategy was used to select able students as participants in the study. Four schools (two large comprehensive, two independent) located in Gloucestershire, England, took part in the study. In total, 175 students from Year 12 took part. The sample contained two groups: science (62 students) and non-science (113 students). Students in the science group were studying at least one A-level in physics, chemistry or biology. A Likert-type scale questionnaire was used and administered during a tutorial period. A Spearman rank test was performed to compare the responses given by science and non-science students. The full report of the study (unpublished PhD thesis) was not available when data extraction was undertaken and the information reported in the journal article was limited in a number of respects.

Hendley et al. (1996a) Pupils' attitudes to technology in Key Stage 3 of the National Curriculum: a study of pupils in South Wales

Topic: This research was part of a larger project that investigated pupils' attitudes to a range of National Curriculum core and foundation subjects in Key Stage 3 during 1993 and 1994. The focus in this paper was solely on technology (specifically, design and technology). Among the attitudes investigated were the reasons pupils gave for choosing this subject for study at GCSE, or for dropping it at this stage.

Data and research methods: Findings from follow-up interviews held with a selection of pupils who had completed the questionnaire used in the first stage of the research were relevant to this review. Interviews were carried out with a total of 47 pupils in South Wales (23 boys and 24 girls). Pupils selected for interview were a representative sample of children from all the schools in the study, in terms of gender and attitude as measured by the questionnaire scale. As part of these interviews, 21 pupils who had opted for technology in Key Stage 4 were asked why they had chosen this subject, and 26 pupils who had dropped it were asked for their reasons for doing so. Responses were grouped by similarity into categories and a frequency analysis was conducted; findings were presented separately for boys and girls.

Jarman et al. (1997) A survey of science at Key Stage 4: Summary of main findings

Topic: The main aims of this survey were to determine: (i) the provision of science courses at Key Stage 4 in Northern Ireland schools and factors influencing this provision; (ii) the uptake of science courses at Key Stage 4 by pupils in Northern Ireland and factors influencing their choice; and (iii) pupils' performance in science at Key Stage 4, their subsequent uptake of school science courses post-16, and factors influencing their choice.

Data and research methods: The research had two distinct strands: a statistical survey of all schools across Northern Ireland and an in-depth study of 30 randomly drawn schools designed to offer insights into, and explanations for, the patterns and trends highlighted in the large-scale statistical survey. The in-depth study produced findings that are relevant to the review. Questionnaires and semi-structured interviews were used to collect data. Questionnaires were administered to around 3000 pupils in the surveyed schools to investigate their attitudes to science and their reasons for choosing particular science programmes. Interviews were held with a random sample of 118 pupils and with school staff, typically on a 'pre-course/post-course' basis. Limited details about some aspects of the study, both methods and findings, were reported in the summary report (the only document available at the time of data extraction).

Johnson (1999) Gender, identity and academic subject choice at school and university

Topic: The broad aim of this doctoral thesis was to explore reasons for, and factors influencing, choice of academic subjects, with particular emphasis on gender differences in subject choice and the unpopularity of science. The research involved a 'school study' (A-level subject choices) and a 'university study' (degree subject choices). The 'school study' examined reasons for both making and changing A-level subject choices and the stability of subject choices during the last year of compulsory education through to the upper sixth-form.

Data and research methods: This longitudinal research project involved analyses of both questionnaire and semi-structured interview data. The Identity Structure Analysis (ISA) framework was adopted to explore issues of identity in subject choice. Only some of the study results are subject-focused; others are about subject choice more generally. The research was conducted in two phases. In the first phase, 408 fifth-year students from grammar schools (four single-sex, four co-educational) in Northern Ireland completed questionnaires. Section two of the questionnaire (which dealt with reasons for A-level choices) was relevant to this review. Four-way ANOVAs were performed for a number of reasons for subject choice, with gender and school type as independent variables. The ANOVAs were used to examine the effects for choice of physics, English, computing and mathematics separately. Only significant results were reported by the author. For the second phase of the study, 245 of the original 408 students completed a second questionnaire (in their upper-sixth year). They were followed up in order to examine if, how and why, their educational choices had changed in the year and a half since the previous, fifth-form study. In an open-ended question format, they were asked to explain any changes in their A-level choices. The final part of the sixth-form phase of the study further explored differences between those who had changed their A-level choices between fifth- and sixth-form and those whose choices had remained stable. It was designed to give a more in-depth view of reasons for changing choices. A further aim was to illuminate issues of gender identity and discipline identity in choice. Semi-structured interviews were conducted with 12 selected sixth-formers (five ‘changers’ and seven ‘non-changers’). They also completed ISA instruments. Interviews lasted 10-15 minutes on average and covered six general areas, including reasons for A-level and degree choices and changes.

Matthews and Pepper (2007) Evaluation of participation in GCE mathematics

Topic: This study aimed to examine reactions to AS- and A-level specifications for mathematics introduced in September 2004. It sought to provide a comprehensive picture of take-up and participation in mathematics at A-level, including students’ reasons for choosing or dropping this subject after GCSE.

Data and research methods: The study drew on numerous different sources of evidence, including national examinations data, large-scale questionnaire surveys and interviews. A questionnaire was sent to a random and representative sample of school and colleges in England, supplemented by an online questionnaire publicised through various sources (200 schools and colleges were invited to complete the questionnaire and 191 responded). Of the 20 institutions that were approached to participate in case studies, 19 agreed. In 2005, 1156 students from 18 case centres completed questionnaires. In 2006, 1151 students from 19 case centres completed questionnaires and 251 students were interviewed. Data were also collected from staff. A range of reasons for subject choices were said to have emerged from the data and details of the most commonly occurring were reported.

McCarthy and Moss (1990) Pupils’ perceptions of technology in the secondary school curriculum: a case study

Topic: This study of students’ attitudes to technology (CDT) included an investigation of the factors influencing choice of technology at both GCSE and A-level.

Data and research methods: The research was conducted at a single 11-18 co-educational comprehensive school in Wales. A total of 40 students completed a questionnaire; slightly different versions were used for GCSE and A-level pupils. Four predefined topics were used in the questionnaires to investigate student attitudes; one of the topics - ‘reasons for choosing technology’ – was relevant to this review. Overall, 30 questionnaires from GCSE pupils and 10 from A-level pupils were returned and used in the data analysis. Findings were presented separately for boys and for girls. The full report of the study (unpublished MEd dissertation) was not available when data extraction was undertaken and limited information was reported in the paper.

Mendick (2006) Masculinities in mathematics

Topic: This research explored reasons why more boys than girls choose to study mathematics at AS-level in England.

Data and research methods: This qualitative research study involved interviews with 43 young people who were all studying post-compulsory mathematics in England. The researcher had prior connections with two of the three institutions participating in the research. Data were collected primarily through interviews (supplemented with observational data). The interviews were semi-structured and varied widely, both in length (ranging from 15 to 40 minutes) and in formality. Students were asked: (1) to describe a typical mathematics lesson, and what they had enjoyed most and least during the year; (2) about the different learning styles used in their classes and about which of their subjects was most similar to mathematics and which most different from it; (3) to give the reasons for their subject choices and for what they hoped to do when they left the sixth form; and (4) about their feelings on gender. The research methods involved writing a story for each interview. In the search for patterns in the data the author grouped the 43 students by their main reason for choosing mathematics (by gender and by social class), and the results of a frequency analysis were presented. The author questioned what was lost in an analysis based on grouping data in this way, thereby 'reducing complexity to single scores'. Consequently, the main focus of the study was to open out these categories by looking for differences as well as similarities within them.

Munro and Elsom (2000) Choosing science at 16: the influence of science teachers and career advisers on students' decisions about science subjects and science and technology careers

Topic: The study aimed to understand the influence of science teachers and careers advisers on pupils' decisions about choosing science subjects and science and technology careers.

Data and research methods: This research utilised two main methods: a questionnaire to career advisors and six case studies involving diverse schools located throughout the UK. The study was carried out in five stages: a) five focus group interviews were held with career advisers to generate ideas and identify the appropriate language to be used in the questionnaire; b) self-completed questionnaires were sent to career advisers working with Year 11 pupils in seven career service companies; c) 165 questionnaires were returned and 155 were included for the analysis; d) telephone interviews were carried out with career adviser managers to clarify issues raised from the questionnaires; e) case studies were carried out in six schools, involving interviews with a range of participants, including head teachers, career advisers, groups of Year 9 and Year 11 pupils, and year group heads.

Reid and Skryabina (2002) Attitudes towards physics

Topic: This study aimed to gain insight into the factors influencing students' intentions towards studying physics in Scotland (at various stages of education).

Data and research methods: This study used a questionnaire to survey 850 Scottish school students (aged 10 years and above) and 208 university students. Samples of students were asked to complete a questionnaire which sought to explore aspects of their attitudes towards physics (or, in the case of younger pupils, science), including reasons influencing their intentions towards continuing with the study of physics (at both Standard and Higher Grade). The questionnaire was not reproduced in the report, but the pupils appear to have been asked to respond to an open-ended question about what had influenced them. The researchers conducted a frequency analysis and the most commonly occurring reasons were reported (percentages given).

Sears (1997) Children's attitudes to science and their choices post-16

Topic: The main focus of this research was children's attitudes to science and their choices post-16. There was a particular interest in whether the introduction of 'double award' GCSE science had any effect on students' attitudes and choices at A-level.

Data and research methods: A questionnaire survey was used to collect data from students in six schools in one county in the South of England. Five of the six participating schools were selected on the basis that they had already been involved in studies concerned with the introduction of 'double award' science. The sixth school was chosen because it gave ready access to large numbers of students from different backgrounds. Responses were gained from 687 students, 554 of whom had completed all sections of the questionnaire. The questionnaire collected three different types of data. Firstly, it asked for students' biographical data and their GCSE English and mathematics results. The second part involved an attitude survey modified from a well-tried instrument. Thirdly, the questionnaire presented students with a series of possible influences on A-level choice, set up as a five-point Likert scale. The author stated that differences between students were looked for by GCSE science background, sex, ability and year group (using chi-squared, t-tests, one-way analysis of variance and cluster analysis). However, in terms of students' reasons for choosing science subjects, very limited relevant findings were reported in the various available reports of this study.

Sharp et al. (1996) The take-up of advanced mathematics and science courses

Topic: This study aimed to establish whether the proportion of students taking mathematics and science A-level courses was affected by characteristics of the school or college and/or by the way in which the teaching of these subjects was organised. The study also sought the views of heads of science and mathematics departments on the factors which encourage or discourage take-up of mathematics and science.

Data and research methods: The main part of the study was based on a large-scale questionnaire survey of all sixth-form and tertiary colleges in England and Wales. Responses were gained from 722 schools (69 per cent of those surveyed) and 136 colleges (75 per cent of those surveyed). The sample of schools was specifically chosen to include those where take-up for science and mathematics A-levels was relatively high, average and low, and those that had experienced increases and decreases in the proportion of sixth-form students specialising in mathematics and science A-levels. The study adopted a statistical approach for the main data analysis. Six school characteristics were investigated as potentially related to take-up (school type, single-sex/co-educational schooling, denominational, region, GCSE results and the percentage of pupils eligible for free school meals). Three college characteristics were investigated (size, type and region). In addition, the views of heads of mathematics and science departments, in both schools and colleges, were collected and the findings presented as the percentage of respondents citing each of the different factors. These findings were based on the coding of open-ended comments from a sample of questionnaires.

Spielhofer et al. (2002) The impact of school size and single-sex education on performance

Topic: The main focus of this research was an investigation of the impact of school size and single-sex education on pupils' performance. A further investigation was carried out to examine the impact of various factors on Key Stage 3 tiers and GCSE subjects taken by pupils.

Data and research methods: This study involved the primary analysis of a national 'value-added' dataset (NVAD for 2001). The database contained matched records of 369,341 pupils from 2954 maintained mainstream schools in England. The main statistical technique employed was multilevel modelling. With regard to school size, logistic regression was used to test the claim that pupils in smaller schools do not have the same range of opportunities as those in larger schools. With regard to single-sex education, it was investigated whether single-sex schools increased or reduced the range of opportunities available to students, and whether they counter or reinforce sex stereotyping, in terms of the subjects taken.

Springate let al. (2002) The factors affecting A-level and undergraduate subject choice in physics and chemistry by ethnic group

Topic: This study investigated the factors influencing the subject decisions of ethnic minority groups. It explored the differences in findings between a) different ethnic groups; b) A-level and university students; c) physics and chemistry students; and d) boys and girls.

Data and research methods: The study employed qualitative methodology and was carried out in two strands. Strand one was designed to be carried out with A-level students. Eleven schools/sixth-form colleges in England with high proportions of ethnic minority students participated in the study. In total, 17 focus groups, involving 80 pupils, were used to gather data; 23 individual interviews were also conducted. Strand two involved individual interviews with 22 undergraduates. The sample included individuals from a range of ethnic minority groups, including Black African, Black Caribbean, Indian, Pakistani, Bangladeshi, and Chinese. Many of the study findings were reported for school and university students combined (and so are not relevant to this review).

Tebbutt (1993) Sixth formers' perceptions of A level and degree courses in physics and mathematics

Topic: The broad aim of this research was to investigate second year sixth-form students' views about A-level and degree subjects, with a particular focus on mathematics and physics. In the second part of the study students were interviewed about their reasons for choice of subjects.

Data and research methods: This study used a questionnaire and semi-structured interviews to gather the views of students; only the interview data are relevant to this review. A total of 421 students from 13 institutions in four local authorities in England completed the questionnaire used in the first part of the study. The second part of the study involved interviews conducted with about five per cent of the questionnaire sample. About half of the main sample came from four sixth-form and tertiary colleges; six comprehensive schools and three selective schools each contributed one quarter. Girls constituted around 26 per cent of the sample, similar to the proportion taking either mathematics or physics at A-level. Based on the biographical data collected via the questionnaire (e.g. GCSE results, number of A-levels taken), the author reported that the group seemed to be 'able'. In the paper, the semi-structured interviews are very briefly discussed (with no clear information on methods). It was acknowledged by the author that due to the constraints of the project very limited analysis was undertaken. A further point made was that the data emerging from the interviews were complex and in some respects contradictory.

Vidal Rodeiro (2007) A level subject choice in England: patterns of uptake and factors affecting subject preferences

Topic: The main aim of this research was to learn how and why students choose their subjects at AS/A-level, how they combine them, what advice is given to them on subject choice and subject combinations and if this is leading to a decline in the selection of certain subjects. The study conducted analyses for both science/mathematics and a broad range of non-STEM subjects/subject areas.

Data and research methods: In this study, two different methods of analysis produced findings that are relevant to the in-depth review question. Both methods were based on data from a large-scale survey, using self-completion questionnaires, conducted in schools/colleges with sixth-form centres in England. Random stratified sampling was used to select the centres (comprehensive schools, grammar schools, independent schools, sixth-form colleges, tertiary colleges and FE colleges). All students within the selected centres were invited to take part in the survey; the response rate was 40 per cent. A total of 6951 students from 60 institutions completed the questionnaire. The first analysis drew on data collected in the second part of the questionnaire (data relating to students' reasons for choice of subjects). Students were presented with a set of 16 different reasons for choosing subjects and were asked to rate how important these reasons were at the time they had to decide which subjects to take. The number of times each reason was rated as 'very important' was calculated and the mean scores reported (with standard deviations). The second analysis drew on biographical and academic background data collected in the first part of the questionnaire. Logistic regression was used to establish statistical associations between students' subject choices and factors likely to influence these choices. The variables included in the model were: gender, ability (prior attainment), social class, school type, urban/rural, ethnicity, and advice.

Wikeley and Stables (1999) Changes in school students' approaches to subject option choices: a study of pupils in the West of England in 1984 and 1996

Topic: The intention of the study was to adopt, as closely as possible, the methodology and sampling procedures of an earlier study (Stables, 1986). By repeating this earlier work, the main aim of the new study was to investigate changes in pupil approaches to GCSE subject option choice following the introduction of the National Curriculum.

Data and research methods: Both questionnaires and interviews were used to gather data; some of the reported findings based on the interview data are relevant to this review. Approximately 1500 pupils in 11 schools in the South West of England completed questionnaires (the whole of the available Year 9 cohort in each school, except those deemed by the schools to have severe reading difficulties). Four single-sex schools were included and there was a good balance of urban and rural schools. Verbal intelligence scores were collected for each child using school records. In addition, a 25 per cent sample of pupils in four schools was selected for interview; 127 out of 144 took part. Of these, 110 were re-interviewed the second year. Pupils were interviewed in the summer term of Year 9, and again in the summer term of Year 10. Interviews (which formed phase two of the study) consisted of open-ended structured questions. The interview schedule covered the following: subject preference and importance, reasons for subject choices, advice sought and given, aspirations and extra-curricular interests. A simple quantifiable content analysis was conducted and chi-squared tests carried out (to establish, for example, where gender differences emerged).

Chapter 6. In-depth review: findings

6.1 Introduction

Each of the included studies addresses the review question: *What factors influence the STEM subject choices made by young people (14-19 years) in the UK?* They do so in two different ways. This broad distinction provided the first level of conceptual distinction for the organisation of the in-depth review and synthesis.

One group of studies used quantitative statistical analysis to identify relationships between a dependent variable (i.e. participation in subjects) and a range of potential independent or explanatory variables (e.g. gender, type of school attended). In other words, they identified whether differences exist in who studies a particular subject, and by implication whether these are then factors in explaining subject choice (for example, they attempted to establish whether, all other things being equal, boys or girls are more likely to study a particular subject). Whilst these studies are important in that they identify unexplained and unexpected differences in levels of participation (and thus subject choice) between one group and another, in themselves they do not offer any explanation for such differences; they do not illuminate *why* one group of students is more likely than another to take a particular subject.

This is what the second group of studies attempts to do, through exploration of the personal roots of choosing (i.e. the role of attitudes, views, feelings, perceptions, etc). A number of different approaches were taken. Most studies asked young people directly for their views and opinions about what motivated them; in other words, *why* they had decided to pursue, or not pursue, particular subjects. Of these, some studies involved the use of questionnaires with predetermined statements for young people to rate or respond to in writing; other studies asked open-ended questions about reasons for subject choices (usually in interviews). Although the data were predominantly numerical (analyses typically involved a frequency count of responses made by respondents), these studies can indicate what young people themselves perceive as influences on their subject choice decisions. This second group of studies also included several that used qualitative methods of enquiry, opting for the method of in-depth interviews to provide the details and context missing from self-completion questionnaires or short interviews. Probing students' perspectives in greater depth has the potential at least to address young people's lack of awareness of all that influences their behaviour (i.e. to uncover 'unconscious drivers' of choice). A small number of studies were longitudinal and/or included observations of participants, thereby addressing some of the limitations of retrospective judgements. Seven studies took a statistical approach to the examination of within-group differences in students' reasons. Two studies investigated through more exhaustive techniques whether attitudinal variables were statistically associated with subject choice.

The reviewed literature also contained two studies that investigated school staff views about which factors encourage/discourage take-up of subjects at the post-compulsory level.

The remainder of this chapter is structured as follows: who made what subject choices (section 6.2), reasons for subject choice decisions (section 6.3), and school staff views on what encourages or discourages take-up of subjects (section 6.4). As students' Key Stage 4 (or equivalent) subject choices are considerably more limited than those for students continuing in education beyond the age of 16, the in-depth review/synthesis was further subdivided according to the stage of education.

6.2 Who made what subject choices?

6.2.1 Introduction

Seven studies investigated statistical associations between students' subject choices and socio-demographic/school-level factors likely to influence those choices. Two focused exclusively on subject choices relating to the final two years of compulsory education (Croxford, 1994; Spielhofer et al., 2002) and five investigated post-16 students (Brown et al., 2008; Cheng et al., 1995; Gallagher et al. 1996; Sharp et al., 1996; Vidal Rodeiro, 2007). Five studies were based on data from England and/or Wales. The study reported in Croxford (1994) focused on subject choice in Scotland, and Northern Ireland was the setting for one study (Gallagher et al., 1996).

6.2.2 Who chooses what subjects for study at Key Stage 4 (14-16 years)?

Overview

Two studies investigated factors influencing students' choice of subjects for their final two years of compulsory education (Croxford, 1994; Spielhofer et al., 2002). In England, Wales and Northern Ireland, student choice has been limited since the introduction of the National Curriculum; Scottish students have similar restrictions on the subjects that can be dropped at age 14. Nonetheless, pupils do have some choice as to what to study (see section 1.5).

Both studies were rated medium/high overall weight of evidence. A range of socio-demographic/school-level variables were investigated as potential influences on students' decisions. Both studies investigated factors associated with the choice of science subjects, technology and modern foreign languages. For further details, see Tables D.1 and D.2 in Appendix D. The factors were:

- individual-level factors
    - gender (two studies)
    - socio-economic status (one study)
    - ability (two studies)
- school-level factors
    - school size (one study)
    - school type: single-sex/co-educational (one study)
    - school type: independent/educational authority (one study)
    - school type: religious denomination (one study)
    - school type: comprehensive/grammar (one study)
    - school type: with sixth-form/without sixth-form (one study)

Gender and choice of KS4 subjects (14-16 years)

Gender differences in subject decisions were found in both studies, although these varied between subjects (see Table 6.1).

The study by Spielhofer et al. (2002) found that girls were less likely than boys to take separate GCSEs in physics, chemistry and biology (i.e. 'triple award' science). The gender effect is virtually the same for all three science subjects, because in any school where the National Curriculum applies (i.e. the great majority) a student cannot take GCSE biology without entering for GCSE chemistry and physics, and similarly for physics and chemistry. In the separate analysis carried out on students who were entered for either ‘double award’ or ‘single award’ GCSE science, this study also found that girls were less likely than boys to be entered for ‘double award’ science. There is no apparent explanation for these results. Similarly, Croxford (1994) found that girls were slightly less likely than boys to take at least one science subject from the scientific studies ‘mode’ (i.e. biology, chemistry, physics or general science). Given the requirement of the Scottish Curriculum Framework (1983) that all pupils study at least one subject/course from each ‘mode of activity’, this gender imbalance seems most likely explained by the gradual implementation of the framework (as suggested by the author).

For technology, the results from the two studies were not in agreement. Croxford (1994) found that girls were more likely than boys to choose a course from the technological activities ‘mode’ (see table 6.1 for further details). In contrast, Spielhofer et al. (2002) found that girls were less likely than boys to be entered for GCSE graphics and also less likely to be entered for GCSE resistant materials. This discrepancy could be explained by the fact that the technological activities in the Croxford study included a much wider range of subjects (including those that are probably more likely to be taken by girls), that the studies were undertaken in different countries[6], and/or that they were undertaken nearly ten years apart.

For modern foreign languages, both studies found that girls were more likely than boys to take this subject at Key Stage 4 (or equivalent). Croxford (1994) also found that girls of this age (14-16 years) were more likely than boys to take creative and aesthetic studies; for social and environmental studies, the opposite finding was reported.

Table 6.1: Gender and choice of KS4 subjects (14-16 years)

Subjects	Studies	Compared to boys, were girls more (>) or less (<) likely to choose the subjects?
Physics	Spielhofer et al. (2002)	<*
Chemistry	Spielhofer et al. (2002)	<*
Biology	Spielhofer et al. (2002)	<*
‘Double award’ science	Spielhofer et al. (2002)	<*
Scientific studies†	Croxford (1994)	<
Technological activities††	Croxford (1994)	>
Design and technology: graphics	Spielhofer et al. (2002)	<*
Design and technology: resistant materials	Spielhofer et al. (2002)	<*
Modern foreign languages	Croxford (1994)	>
Social and environmental studies	Croxford (1994)	<
Creative and aesthetic studies	Croxford (1994)	>
French and German	Spielhofer et al. (2002)	>

* $p \leq 0.05$
† Scientific studies mode: students choose from biology, chemistry, physics, science.
†† Technological activities mode: students choose from computing studies, craft and design, home economics, office and information studies, technological studies.

Ability and choice of KS4 subjects (14-16 years)

Two studies investigated the effect of ability (prior attainment) on students’ subject choices for the final two years of compulsory education (see Table 6.2).

[6] The fact that the Croxford study was undertaken in Scotland should be taken into account when reading all findings from the Key Stage 4 synthesis.

The study by Spielhofer et al. (2002) found that students with lower prior attainment (Key Stage 2 average level) were less likely than students with higher achievement levels to take GCSEs in physics, graphics or resistant materials. No statistically significant differences were found between students of different ability in entering for GCSEs in chemistry or biology. In a separate analysis carried out on students who were entered for either 'double award' or 'single award' GCSE science, this study found that students with lower prior attainment were more likely to be entered for 'double award' science than students (in this sub-sample) with higher ability. There is no clear explanation for this counter-intuitive result. The study by Croxford (1994) used students' average attainment in SCE Ordinary or Standard Grade examinations as a proxy for ability. The study found that, when compared to pupils of higher measured ability, pupils of low or medium ability were less likely to study a science subject, but more likely to study technology.

For modern foreign languages, both studies found that lower ability students were less likely than those of higher ability to take this subject. Croxford (1994) also found that lower ability students were less likely to take social and environmental studies; for creative and aesthetic studies, the opposite finding was reported.

Table 6.2: Ability and choice of KS4 subjects

Subjects	Studies	Compared to higher ability, were students with lower ability more (>) or less (<) likely to choose the subjects?
Physics	Spielhofer et al. (2002)	<*
Chemistry	Spielhofer et al. (2002)	x
Biology	Spielhofer et al. (2002)	x
'Double award' science	Spielhofer et al. (2002)	>*
Scientific studies†	Croxford (1994)	<
Design and technology: graphics	Spielhofer et al. (2002)	<*
Design and technology: resistant materials	Spielhofer et al. (2002)	<*
Technological activities††	Croxford (1994)	>
Modern foreign languages	Croxford (1994)	<
Social and environmental studies	Croxford (1994)	<
Creative and aesthetic studies	Croxford (1994)	>
French and German	Spielhofer et al. (2002)	<

* $p \leq 0.05$
x Relationship investigated, but found to be non-significant (at 5% level) and estimate not reported.
† Scientific studies mode: students choose from biology, chemistry, physics, science.
†† Technological activities mode: students choose from computing studies, craft and design, home economics, office and information studies, technological studies.

Socio-economic status (SES) and choice of KS4 subjects (14-16 years)

One study investigated the influence of socio-economic status on student subject choice (see table 6.3).

Using 'father's occupation' as a broad categorisation of social class, the study found that pupils from manual families were less likely than those from non-manual families to study a scientific subject, all other things being equal. However, the effect of SES on the probability of studying a subject from the technological activities 'mode' was different. The results suggest that pupils whose parents come from manual backgrounds are more likely to study technology than those from non-manual families.

Among non-STEM subjects, pupils from manual families were less likely to study modern languages, when compared to those from non-manual families. For the other subjects investigated, there was almost no difference in uptake of subjects between students from manual and non-manual backgrounds.

Table 6.3: Socio-economic status and choice of KS4 subjects

Subjects	Studies	Compared to students from non-manual backgrounds, were students from manual backgrounds more (>), less (<) or equally (=) likely to choose the subjects?
Scientific studies†	Croxford (1994)	<
Technological activities††	Croxford (1994)	>
Modern foreign languages	Croxford (1994)	<
Social and environmental studies	Croxford (1994)	=
Creative and aesthetic studies	Croxford (1994)	=

† Scientific studies mode: students choose from biology, chemistry, physics, science.
†† Technological activities mode: students choose from computing studies, craft and design, home economics, office and information studies, technological studies.

School size and choice of KS4 subjects (14-16 years)

One study investigated the influence of school size on students' selection of subjects for the final two years of compulsory education (see table 6.4).

Spielhofer et al. (2002) found that students in large schools were more likely to be entered for separate GCSEs in physics, biology and chemistry than students in medium schools; students in small schools had the least chance of being entered for 'triple science'. It is noteworthy that the study also found that larger schools offered a wider range of subjects. A separate analysis suggested that the probability of a student entering for 'double award' rather than 'single award' science was higher in large schools and lower in small schools.

For design and technology subjects, pupils in small schools were found to be less likely to take GCSE graphics, but more likely to take resistant materials at GCSE, when compared to pupils from medium schools. Differences between medium and large schools were not statistically significant.

Table 6.4: School size and choice of KS4 subjects

Subjects	Studies	Compared to students from middle sized schools, were those from other schools more (>) or less (<) likely to choose the subjects?	
		Small schools	Large schools
Physics	Spielhofer et al. (2002)	<*	>*
Chemistry	Spielhofer et al. (2002)	<*	>*
Biology	Spielhofer et al. (2002)	<*	>*
'Double award' science	Spielhofer et al. (2002)	<*	>*
Design and technology: graphics	Spielhofer et al. (2002)	< *	x

Design and technology: resistant materials	Spielhofer et al. (2002)	>	x
French and German	Spielhofer et al. (2002)	x	<*

* p≤0.05
x Relationship investigated, but found to be non-significant (at 5% level) and estimate not reported.

School type (single-sex/co-educational) and choice of KS4 subjects (14-16 years)

One study investigated the influence of school type (single-sex/co-educational) on student subject choice (see table 6.5).

Spielhofer et al. (2002) found that students from single-sex schools (both boys' and girls' schools) had a higher chance of taking separate GCSEs in physics, chemistry and biology than students from mixed-sex schools. In a separate analysis, the study found that boys from single-sex schools were less likely to take GCSE 'double award' science than those from comprehensive schools.

For design and technology (both graphics and resistant materials), girls in girls-only schools were more likely than girls in mixed schools to take GCSEs in these subjects. However, the study found that there was no statistically significant difference between boys in boys' schools and boys in mixed-sex schools in terms of being entered for design and technology subjects.

Table 6.5: School type (single-sex/co-educational) and choice of KS4 subjects

Subjects	Studies	Compared to mixed schools, were other types of schools more (>) or less (<) likely to choose the subjects?	
		Single-sex boys' schools	Single-sex girls' schools
Physics	Spielhofer et al. (2002)	>*	>*
Chemistry	Spielhofer et al. (2002)	>*	>*
Biology	Spielhofer et al. (2002)	>*	>*
'Double award' science	Spielhofer et al. (2002)	<*	x
Design and technology: graphics	Spielhofer et al. (2002)	x	>*
Design and technology: resistant materials	Spielhofer et al. (2002)	x	>*
French and German	Spielhofer et al. (2002)	x	<*

* p≤0.05
x Relationship investigated, but found to be non-significant (at 5% level) and estimate not reported.

School type (independent/education authority) and choice of KS4 subjects (14-16 years)

One study investigated the influence of school type (independent/education authority) on student subject choice (see table 6.6).

The study by Croxford (1994) found that pupils from independent schools were more likely than pupils from education authority schools to take scientific studies, social and environment studies, or modern languages, all other things being equal. It also found that pupils from independent schools were less likely than those from education authority schools to take technology or creative and aesthetic studies.

Table 6.6: School type (independent/educational authority) and choice of KS4 subjects

Subjects	Studies	Compared to students from education authority schools, were students from independent schools more (>) or less (<) likely to choose the subjects?
Scientific studies†	Croxford (1994)	>
Technological activities††	Croxford (1994)	<
Modern foreign languages	Croxford (1994)	>
Social and environmental studies	Croxford (1994)	>
Creative and aesthetic studies	Croxford (1994)	<

† Scientific studies mode: students choose from biology, chemistry, physics, science.
†† Technological activities mode: students choose from computing studies, craft and design, home economics, office and information studies, technological studies.

School type (religious denomination) and choice of KS4 subjects (14-16 years)

One study investigated the influence of school type (religious denomination) on student subject choice (see table 6.7).

The study found that pupils from Catholic schools were more likely than those from non-denominational schools to take scientific studies, social and environmental studies or modern languages. However, they were found to be less likely than pupils from non-denominational schools to take technology or creative and aesthetic studies.

Table 6.7: School type (religious denomination) and choice of KS4 subjects

Subjects	Studies	Compared to students from non-denominational schools, were students from Catholic schools more (>) or less (<) likely to choose the subjects?
Scientific studies†	Croxford (1994)	>
Technological activities††	Croxford (1994)	<
Modern foreign languages	Croxford (1994)	>
Social and environmental studies	Croxford (1994)	>
Creative and aesthetic studies	Croxford (1994)	<

† Scientific studies mode: students choose from biology, chemistry, physics, science.
†† Technological activities mode: students choose from computing studies, craft and design, home economics, office and information studies, technological studies.

School type (comprehensive/grammar) and choice of KS4 subjects (14-16 years)

One study investigated the influence of school type (comprehensive/grammar) on student subject choice (see table 6.8).

The study by Spielhofer et al. (2002) found that pupils from comprehensive schools were less likely to be entered for separate GCSEs in physics, chemistry and biology than those from grammar schools. Students from comprehensive schools were more likely to be entered for GCSEs in graphics and resistant materials than students from grammar schools.

Table 6.8: School type (grammar/comprehensive) and choice of KS4 subjects

Subjects	Studies	Compared to students from grammar schools, were students from comprehensive schools more (>) or less (<) likely to choose the subjects?
Physics	Spielhofer et al. (2002)	<*
Chemistry	Spielhofer et al. (2002)	<*
Biology	Spielhofer et al. (2002)	<*
'Double award' science	Spielhofer et al. (2002)	x
Design and technology: graphics	Spielhofer et al. (2002)	>*
Design and technology: resistant materials	Spielhofer et al. (2002)	>*
French and German	Spielhofer et al. (2002)	<*

* p≤0.05
x Relationship investigated, but found to be non-significant (at 5% level) and estimate not reported.

School type (with sixth-form/without sixth-form) and choice of KS4 subjects (14-16 years)

One study investigated the influence of school type (with sixth-form/without sixth-form) on student subject choice (see table 6.9).

Spielhofer et al. (2002) found that students from schools without sixth-forms were more likely to be entered for separate GCSEs in physics, chemistry and biology than students from schools with a sixth-form. In a separate analysis, it was found that students from schools without sixth-forms were also more likely to be entered for 'double award' science than students from schools with a sixth-form.

Table 6.9: School type (with sixth-form/without sixth-form) and choice of subjects

Subjects	Studies	Compared to students from schools with sixth-forms, were students from school without sixth-forms more (>) or less (<) likely to choose the subjects?
Physics	Spielhofer et al. (2002)	>*
Chemistry	Spielhofer et al. (2002)	>*
Biology	Spielhofer et al. (2002)	>*
'Double award' science	Spielhofer et al. (2002)	>*
Design and technology: graphics	Spielhofer et al. (2002)	x
Design and technology: resistant materials)	Spielhofer et al. (2002)	x
French and German	Spielhofer et al. (2002)	>*

* p≤0.05
x Relationship investigated, but found to be non-significant (at 5% level) and estimate not reported.

6.2.3 Who chooses what subjects post-16?

Overview

Five studies aimed to measure statistical associations between students' post-16 subject choices and factors likely to influence those choices (Brown et al., 2008; Cheng et al., 1995; Gallagher et al., 1996; Sharp et al., 1996; Vidal Rodeiro, 2007). A range of socio-demographic/school-level variables were investigated. All five studies focused on students' choice of mathematics and/or science subjects. Of these, one study also conducted an analysis for modern foreign languages (Vidal Rodeiro, 2007). For further details, see tables D.1 and D.3 in Appendix D. The factors studied were:

- individual-level factors
    - gender (one study)
    - socio-economic status (four studies)
    - ethnicity (two studies)
    - ability (three studies)
    - type of science course taken at GCSE (two studies)
- school-level factors
    - geographical region (one study)
    - location (urbanicity) (one study)
    - college size (one study)
    - school status (one study)
    - school type: single-sex/co-educational (three studies)
    - school type: religious denomination (two studies)
    - school type: comprehensive/grammar/etc (two studies)
    - school/college academic attainment (one study)
    - qualifications of teaching staff (two studies)
    - gender ratio of teaching staff (two studies)
    - setting by ability (one study)
    - teaching time allocated to subjects pre-16 (one study)
    - advice (various sources, both school and family) (one study)
    - other (one study)

Gender and post-16 subject choice

One study investigated the effect of gender on the subject choices of students staying on in education after the age of 16 (Vidal Rodeiro, 2007). It was rated medium/high overall weight of evidence.

Table 6.10: Gender and post-16 subject choice

Study	Subject	Compared to boys, were girls more (>) or less (<) likely to choose the subject at A-level?
Vidal Rodeiro (2007)	Science/mathematics	<*
Vidal Rodeiro (2007)	Modern foreign languages	>*

* p≤0.05

The study found an effect for gender; however, this varied between subjects. Whilst boys were more likely than girls to choose two or more science/mathematics subjects, girls were more likely than boys to be studying at least one modern foreign language.

Socio-economic status (SES) and post-16 subject choice

Four studies investigated the influence of socio-economic status on students' post-16 subject choices. Two studies were judged to be medium/high overall weight of evidence (Cheng et al., 1995; Vidal Rodeiro, 2007). The remaining two studies were rated low/medium (Gallagher et al., 1996; Sharp et al., 1996).

Table 6.11: Socio-economic status and post-16 subject choice

Study	Subject	Compared to students from high SES backgrounds, were those from lower SES backgrounds more (>) or less (<) likely to choose the subject at A-level?
Vidal Rodeiro (2007)	Science/mathematics	<*
Gallagher et al. (1996)	Science/mathematics	<
Cheng et al. (1995)	Physical sciences	>
Cheng et al. (1995)	Mathematics	>*
Cheng et al. (1995)	Life sciences	>
Sharp et al. (1996)	Mathematics	<*
Sharp et al. (1996)	Physics	<*
Sharp et al. (1996)	Chemistry	<*
Sharp et al. (1996)	Biology	<*
Vidal Rodeiro (2007)	Modern foreign languages	<*

* $p \leq 0.05$ (for at least some of the within-variable comparisons)

In three studies, SES was based on parental occupation (Cheng et al., 1995; Gallagher et al., 1996; Vidal Rodeiro, 2007).[7] Sharp et al. (1996) used the proportion of pupils eligible for free school meals as an indicator of economic deprivation.[8] Overall, the research provided mixed evidence, with only three of the four studies finding that lower SES was related to lower take-up in science/mathematics subjects. However, two of these studies (Gallagher et al., 1996; Sharp et al., 1996) did not control for prior attainment, so what looks like an SES 'effect' may actually be that of prior attainment (e.g. GCSE results). A possible explanation for the opposite results found by the two medium/high weight of evidence studies that used regression analysis (Cheng et al., 1995; Vidal Rodeiro, 2007) could be the different compositions of the study samples; Cheng et al. (1995) excluded independent schools from their analysis. Further differences between the studies relate to the different ways that subjects were grouped for the analyses that were conducted. In Cheng et al. (1995) subjects were grouped into one of three categories (life sciences, physical sciences or mathematics) and each of these subject areas was subjected to a separate analysis. In the study by Vidal Rodeiro (2007) the analysis centred on students who had chosen *two or more* science/mathematics A-levels. In addition to the lack of comparability between these subject groupings, Vidal Rodeiro (2007) would appear to have focused on students who were specialising in the STEM field. Differences between these students (i.e. STEM specialists) and those who opt for only one A-level in this area might also account for the opposite findings. Alternatively, the discrepancy may be due to the small size of the estimated effects.

Ethnicity and post-16 subject choice

Two studies investigated the influence of ethnicity on students' post-16 subject choices (Cheng et al., 1995; Vidal Rodeiro, 2007). They were both rated medium/high overall weight of evidence.

Table 6.12: Ethnicity and post-16 subject choice

Subject	Study	Compared with white students, were minority ethnic groups more (>) or less (<) likely to choose the subjects listed?

[7] Cheng et al. (1995) also used parental education and employment status as indicators of SES; findings were similar.
[8] The study by Sharp et al. (1996) investigated this as a school-level variable..

		Black	Black African	Black Caribbean	Black other	Asian	Indian	Pakistani	Bangladeshi	Chinese	Mixed-heritage
Science/ mathematics	Vidal Rodeiro (2007)		>*	<	>		>*	>*	>	>*	>*
Physical sciences	Cheng et al. (1995)	>				>*					
Mathematics	Cheng et al. (1995)	>				>*					
Life sciences	Cheng et al. (1995)	<				>*					
Modern foreign languages	Vidal Rodeiro (2007)		<	>	<		<*	<*	<*	<	>

* p≤0.05

Both studies found differences in subject choice by ethnic group. For some STEM subjects, both studies found that, other things being equal, most minority ethnic groups were more likely than white students to take these subjects at A-level. Possible explanations for the two opposite results that indicate that Black/Black Caribbean students were less likely than white students to take science-related subjects are: (i) the small sample sizes for Black students (both studies); (ii) the focus in the study by Vidal Rodeiro (2007) on students who had chosen two or more science/mathematics subjects; or (iii) this study's grouping together of science/ mathematics subjects (in contrast to the more specialised categories used in the analyses conducted by Cheng and colleagues).

One study investigated factors influencing uptake of a non-STEM subject. It found that, other things being equal, students from most minority ethnic groups were less likely than white students to take modern foreign languages at A-level.

Ability and post-16 subject choice

Three studies investigated the relationship between measured ability (i.e. prior attainment) and selection of subjects at A-level. Two studies were rated medium/high overall weight of evidence (Cheng et al., 1995; Vidal Rodeiro, 2007); the study by Brown et al. (2008) was rated medium.

Table 6.13: Ability and post-16 subject choice

Effect on choice of which subject?	Study	Compared to high ability students, were lower ability students more (>) or less (<) likely to choose the subject at A level?			
		Lower ability students	B-C GCSE physical sciences grades	B-C GCSE mathematics grades	B-C GCSE biology grades
Science/mathematics	Vidal Rodeiro (2007)	<*			
Mathematics	Brown et al. (2008)	>			
Physical sciences	Cheng et al. (1995)		<*	<*	>
Mathematics	Cheng et al. (1995)		<*	<*	>

Life sciences	Cheng et al. (1995)		<*	>*	<*
Modern foreign languages	Vidal Rodeiro (2007)	<*			

* p≤0.05

In two studies, most of the analyses suggest that high ability students were more likely than lower ability students to take science/mathematics subjects at A-level. Brown et al. (2008) reported the counter-intuitive finding that low achievers were slightly more likely to take A-level mathematics than higher achievers. There are a number of possible explanations for this apparent difference in results between the studies. Firstly, ability was measured in different ways. Cheng et al. (1995) investigated the effect of students' grades in three different subjects taken at GCSE (mathematics, physical science, biology) on the choice of subjects at A-level. Vidal Rodeiro (2007) used a measure of student ability that was based on *all* GCSE grades. In contrast, *predicted* GCSE grades were used in the analysis by Brown et al. (2008). Secondly, the results reported in Brown et al. (2008) were based on *intention* to participate in A-level mathematics. As the Cheng et al. (1995) and Vidal Rodeiro (2007) studies were based on actual GCSE grades and actual subject choices, we have more confidence in the results provided by these studies.

Further analyses (not shown in table 6.13) conducted by Cheng et al. (1995) suggested that GCSE results were a more important influence for girls than for boys, although none of the findings were statistically significant.

The study by Cheng et al. (1995) also investigated the influence of the number of A*-C grades in non-science subjects on A-level subject choice (not shown in table 6.13). It found that the greater the number of passes in arts, humanities and social science GCSEs, the lower the probability of taking physical sciences, mathematics or life sciences at A-level.

Vidal Rodeiro (2007) conducted an analysis for modern foreign languages. As was the case with STEM subjects, the study found that students with poorer GCSE grades were less likely to take A-levels in MFL than those with higher GCSE grades. This relationship was found to be weaker than that between ability and uptake of mathematics/science subjects.

Type of science course taken at GCSE and post-16 subject choice

Two studies investigated a second academic background variable: the type of science course taken at GCSE.[9] One study was rated medium/high overall weight of evidence (Cheng et al., 1995) and the other was rated low/medium (Sharp et al., 1996).

Table 6.14: Type of science course taken at GCSE and post-16 subject choice

Study	Subject	Compared to students who had taken separate sciences at GCSE, were students who had taken 'double award' science more (>) or less (<) likely to choose the subject at A-level?
Cheng et al. (1995)	Physical sciences	<*
Cheng et al. (1995)	Mathematics	<*
Cheng et al. (1995)	Life sciences	>*

[9] Cheng et al. (1995) also investigated the influence of other subjects/subject combinations taken at GCSE (see Appendix E for details).

Sharp et al. (1996)	Physics	<*
Sharp et al. (1996)	Chemistry	<*
Sharp et al. (1996)	Biology	<*

* p≤0.05

Both studies found a relationship between the type of science course taken at GCSE and subject choice. All but one of the analyses suggested that taking ‘double award’ science at GCSE instead of the three separate sciences had a detrimental effect on the take-up of mathematics/science subjects at A-level. There are no apparent methodological or contextual explanations for the opposite effect found by Cheng et al. (1995) for life sciences (defined as biology, botany, zoology).

Geographical region and post-16 subject choice

One study investigated the effect of geographical region on students’ choice of mathematics and science subjects (Sharp et al., 1996). It was rated low/medium overall weight of evidence.

Table 6.15: Geographical region and post-16 subject choice

Study	Subject	Compared to similar <u>schools</u> located elsewhere, did <u>schools</u> located in the South West and East Midlands have higher (>) or lower (<) take-up of the subjects listed?	Compared to similar <u>colleges</u> located elsewhere, did <u>colleges</u> located in located in the South West and East Midlands have higher (>) or lower (<) take-up of the subjects listed?
Sharp et al. (1996)	Physics	>*	>*
Sharp et al. (1996)	Biology	x	>*
Sharp et al. (1996)	Mathematics	x	x
Sharp et al. (1996)	Chemistry	x	x

* p≤0.05
x Relationship investigated, but found to be non-significant (at 5% level) and estimate not reported.

The study found that, for some STEM subjects, schools and/or colleges located in the South West and East Midlands had higher take-up than similar schools/colleges elsewhere. For physics, this applied only to comprehensive and secondary modern schools; for biology, this applied only to colleges. As results for other regions were not statistically significant, they were not reported by the authors.

Urbanicity and post-16 subject choice

One study investigated the effect of urbanicity on students’ choice of subjects (Vidal Rodeiro, 2007). It was rated medium/high overall weight of evidence.

Table 6.16: Urbanicity and post-16 subject choice

Study	Subject	Compared with students attending schools in urban locations, were those attending schools in less populated locations more (>), less (<), or equally (=) likely to choose the subjects listed?		
		Town and fringe	Village	Hamlet and isolated dwelling
Vidal Rodeiro	Science/mathematics	>	>	=

(2007)				
Vidal Rodeiro (2007)	Modern foreign languages	>	<	<

* p≤0.05

Vidal Rodeiro (2007) found that, compared to students living in urban areas, those living in less populated areas were on the whole slightly more likely to take at least two science/mathematics subjects at A-level. For modern foreign languages, the most remotely located students (those living in villages, hamlets and isolated dwellings) were more likely to take modern foreign languages at A-level than urban students. None of the results were reported as being statistically significant.

School/college size and post-16 subject choice

One study investigated whether the size of colleges attended by students was related to the take-up of science/mathematics A-levels (Sharp et al., 1996). It was rated low/medium overall weight of evidence. No studies investigated the influence of the size of schools on subject choice.

Table 6.17: College size and post-16 subject choice

Study	Subject	Compared with students in smaller colleges (<500 students), were students in larger colleges more (>) or less (<) likely to choose the subjects listed?
Sharp et al. (1996)	Physics	<*
Sharp et al. (1996)	Chemistry	<*
Sharp et al. (1996)	Biology	<*
Sharp et al. (1996)	Mathematics	x

* p≤0.05
x Relationship investigated, but found to be non-significant (at 5% level) and estimate not reported.

The study found that the there was a statistically significant relationship between the size of colleges and A-level take-up in the three science subjects: physics, chemistry and biology. Smaller colleges (defined as those with 550 or fewer students) had the highest take-up for physics.

School/college status (degree of autonomy of the school management) and post-16 subject choice

One study investigated the influence of school status (defined as the degree of autonomy of the school management) on students' choice of A-level subjects (Cheng et al., 1995). This study was rated medium/high overall weight of evidence.

Table 6.18: School status and post-16 subject choice

Study	Subject	Compared with students from voluntary-aided† schools, were students from other types of schools more (>) or less (<) likely to choose the subjects listed?		
		LEA maintained††	Voluntary controlled†††	Special agreement††††
Cheng et al. (1995)	Physical sciences	<	<	<
Cheng et al. (1995)	Mathematics	<*	<*	<
Cheng et al. (1995)	Life sciences	>	<	>

* p≤0.05
† Voluntary-aided: mainly religious or 'faith' schools, part-funded by the local authority, governing body and charity, and with the governing body responsible for running school.
†† LEA (local education authority) maintained: schools that are under local authority control and receive their funding from central government.
††† Voluntary-controlled: similar to voluntary-aided schools, but are funded and run by the local authority.
†††† Special agreement: similar to voluntary-aided, with a foundation (generally religious) which appoints the majority of the governing body.

For mathematics and physical sciences, the study found that students from voluntary schools were more likely than students attending the other types of schools to take these subjects at A-level. The findings for life sciences were contradictory. Possible explanations for these findings include: (i) students from special agreement schools formed only a small proportion of the sample (1.6 per cent); and (ii) the result for LEA maintained schools was virtually zero (0.01). On the whole, caution is required, as few of these effects were statistically significant.

School/college type (single-sex/co-educational) and post-16 subject choice

Three studies investigated the effect of school type (single-sex/co-educational schooling) on students' post-16 subject choices. One study was judged as medium/high overall weight of evidence (Cheng et al., 1995) and the others were rated low/medium quality (Gallagher et al., 1996; Sharp et al., 1996).

Table 6.19: School-type (single-sex, co-educational) and post-16 subject choice

Study	Subject	Compared to boys in co-educational schools, were boys in single-sex schools more (>) or less (<) likely to choose the subjects listed?	Compared to girls in co-educational schools, were girls in single-sex schools more (>) or less (<) likely to choose the subjects listed?
Sharp et al. (1996)	Mathematics	>*	x
Sharp et al. (1996)	Physics	>*	x
Sharp et al. (1996)	Chemistry	x	x
Sharp et al. (1996)	Biology	x	>*
Gallagher et al. (1996)	Science/mathematics	<*	<*
Cheng et al. (1995)†	Physical sciences		<*
Cheng et al. (1995)	Mathematics		<*
Cheng et al. (1995)	Life sciences		<*

* p≤0.05
† The study by Cheng et al. (1995) did not compare boys in single-sex schools to boys in mixed-sex schools.
x Relationship investigated, but found to be non-significant (at 5% level) and estimate not reported.

The available research on the effects of single-sex education on subject choice provided mixed evidence. Of the two studies examining the effects on boys, one found that single-sex schooling increased their likelihood of taking science/mathematics subjects (Gallagher et al., 1996), while the other study found the opposite result (Sharp et al., 1996). However, neither study controlled for prior attainment. In the case of girls, two studies found that single-sex schooling reduced their likelihood of taking science/mathematics subjects (Cheng et al., 1995; Gallagher et al., 1996), while the third study found the opposite to be the case (Sharp et al., 1996). In their main analysis, Cheng et al. (1995) controlled for a number of factors, including prior attainment.

Cheng et al. (1995) fitted a second model excluding all the variables relating to GCSE subjects and results. In this analysis, girls in mixed schools were less likely than girls educated in single-sex schools to study mathematics/science subjects (not shown in table 6.19). The authors argue that the findings from this model suggest that it is the subjects studied at GCSE and the results obtained in these that produce the difference in A-level choices between girls in single-sex and mixed-sex schools. In other words, the difference in participation between the groups is due to the different pattern of subjects studied and the higher levels of attainment at girls' schools, rather than single-sex education per se.

School/college type (religious denomination) and post-16 subject choice

Two studies investigated the influence of the religious denomination of schools on students' subject choices (Gallagher et al., 1996; Sharp et al., 1996). They were both rated low/medium overall weight of evidence.

The study by Gallagher et al. (1996) was conducted with a sample of pupils from Northern Ireland; the focus was on mathematics/science A-levels and take-up was found to be highest in Protestant schools. The study by Sharp et al. (1996) was based in England and Wales. For mathematics, this study found that the proportion of students taking this subject at A-level was related to the religious denomination of schools attended, and that take-up was highest in Church of England and Methodist schools.[10] For physics, chemistry and biology no statistically significant relationships were found.

School/college type (comprehensive/grammar/etc) and post-16 subject choice

Two studies investigated the influence of the type of school/college attended (comprehensive/grammar/etc) on students' A-level subject choices. One study was judged as medium/high overall weight of evidence (Vidal Rodeiro, 2007) and the other low/medium (Sharp et al., 1996).

Vidal Rodeiro (2007) compared subject uptake in comprehensive schools with that in grammar, independent, sixth-form and further education/tertiary colleges. The study by Sharp et al. (1996) compared comprehensive/secondary modern schools with both independent and grammar schools.

Table 6.20: School type (comprehensive, sixth-form, etc) and post-16 subject choice

<table>
<tr><th rowspan="2">Study</th><th rowspan="2">Subject</th><th colspan="4">Compared to students in comprehensive† schools, were students in other types of schools more (>) or less (<) likely to choose the subjects listed?</th></tr>
<tr><th>Grammar schools</th><th>Independent schools</th><th>Sixth-from colleges</th><th>FE/tertiary colleges</th></tr>
<tr><td>Sharp et al. (1996)</td><td>Mathematics</td><td colspan="2">>*</td><td colspan="2" rowspan="4"></td></tr>
<tr><td>Sharp et al. (1996)</td><td>Physics</td><td colspan="2">>*</td></tr>
<tr><td>Sharp et al. (1996)</td><td>Chemistry</td><td colspan="2">>*</td></tr>
<tr><td>Sharp et al. (1996)</td><td>Biology</td><td colspan="2">x</td></tr>
<tr><td>Vidal Rodeiro (2007)</td><td>Science/ mathematics</td><td>></td><td>></td><td>></td><td>></td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Vidal Rodeiro (2007)</td><td>Modern foreign languages</td><td>>*</td><td>>*</td><td>></td><td><*</td></tr>
</table>

* p≤0.05
† Including secondary modern
x Relationship investigated, but found to be non-significant (at 5% level) and estimate not reported.

[10] No further details are provided in the summary report of this study.

Both studies found that A-level choices were influenced by the types of schools/colleges attended. Both studies found that students from grammar/independent schools were more likely than students from comprehensive schools to take science/mathematics subjects post-16.

Sharp and colleagues conducted separate analyses for schools and for colleges. A comparison of take-up at sixth-form colleges with numbers studying science/mathematics A-levels at tertiary colleges indicated that chemistry A-level take-up was significantly higher in sixth-form colleges (not represented in table 6.20). This was the only statistically significant result.

Vidal Rodeiro (2007) also found that students from grammar/independent schools were more likely than students from comprehensive schools to take modern foreign languages at A-level.

School/college academic attainment and post-16 subject choice

One study investigated the influence of school/college academic attainment on students' subject choices (Sharp et al., 1996). It was rated low/medium overall weight of evidence.

Two measures of school/college academic attainment were used: the proportion of students achieving five or more A*-C grade GCSEs (measure 1); and the proportion of students who gained A*-C passes in science-related A-levels (measure 2).

For colleges, the study found no relationship between this variable and the take-up of any of the four subjects (not detailed in table 6.21).

Table 6.21: Schools' academic attainment and post-16 subject choice

Study	Subject	Compared to students in higher attaining schools, were those in lower attaining schools more (>) or less (<) likely to choose the subjects listed? MEASURE 1 (GCSE passes)	Compared to students in higher attaining schools, were those in lower attaining schools more (>) or less (<) likely to choose the subjects listed? MEASURE 2 (A-level passes)
Sharp et al. (1996)	Mathematics	**<***	x
Sharp et al. (1996)	Physics	**<***	**<***
Sharp et al. (1996)	Chemistry	**<***	**<***
Sharp et al. (1996)	Biology	**<***	**<***

* p≤0.05
x Relationship investigated, but found to be non-significant (at 5% level) and estimate not reported.

For schools, the findings from the single study in this group show a consistent pattern. The study found that the proportion of students passing five or more GCSEs was significantly related to take-up for all four subjects, with higher achieving schools having the highest take-up. At A-level, the proportion of students passing physics, chemistry and biology was significantly related to higher A-level take–up in these subjects the following academic year. In physics, there was a relationship for this variable among comprehensive and secondary modern schools only. No significant relationship was found for mathematics.

Qualifications of teaching staff and post-16 subject choice

Two studies investigated the influence of the level of teaching staff qualifications on students' choice of subjects. One study was rated medium/high overall weight of evidence (Cheng et al., 1995) and the other study was rated low/medium (Sharp et al., 1996).

Table 6.22: Qualification level of school/college staff and post-16 subject choice

Study	Subject	Compared to students in schools with staff highly qualified in the subject concerned, were those in schools with lower qualified staff more (>) or less (<) likely to choose the subjects listed?	Compared to students in colleges with staff highly qualified in the subject concerned, were those in colleges with lower qualified staff more (>) or less (<) likely to choose the subjects listed?
Sharp et al. (1996)	Mathematics	x	x
Sharp et al. (1996)	Physics	<*	<*
Sharp et al. (1996)	Chemistry	x	x
Sharp et al. (1996)	Biology	<*	>*
Cheng et al. (1995)	Physical sciences	x	
Cheng et al. (1995)	Mathematics	x	
Cheng et al. (1995)	Life sciences	x	

* $p \leq 0.05$
x Relationship investigated, but found to be non-significant (at 5% level) and estimate not reported.

One study found some statistically significant relationships, although the pattern was not consistent (Sharp et al., 1996). The lower take-up of physics and biology in schools with less well qualified staff was found for independent and grammar schools only.

Gender ratio among teaching staff and post-16 subject choice

Two studies investigated the influence of the gender ratio amongst staff on students' choice of subjects. One study was rated medium/high overall weight of evidence (Cheng et al., 1995) and the other study was rated low/medium (Sharp et al., 1996).

Table 6.23: Gender ratio among teaching staff and post-16 subject choice

Study	Subject	Compared to students in schools with high proportions of female teachers were those in schools with lower proportions of female staff more (>) or less (<) likely to choose the subjects listed?	Compared to students in colleges with high proportions of female teachers, were those in colleges with lower proportions of female staff more (>) or less (<) likely to choose the subjects listed?
Sharp et al. (1996)	Mathematics	x	<*
Sharp et al. (1996)	Physics	<*	x
Sharp et al. (1996)	Chemistry	x	x
Sharp et al. (1996)	Biology	x	x
Cheng et al. (1995)	Physical sciences	x	
Cheng et al. (1995)	Mathematics	x	
Cheng et al. (1995)	Life sciences	x	

* p≤0.05
x Relationship investigated, but found to be non-significant (at 5% level) and estimate not reported.

The study by Sharp et al. (1996) found that, in colleges, higher take-up for mathematics A-level was related to higher proportions of female mathematics teachers. In schools, higher take-up for physics A-level was related to higher proportions of female science teachers (independent and grammar schools only).

Setting by ability and post-16 subject choice

One study investigated the influence of the practice of setting by ability for subjects taken pre-16 (i.e. for GCSE courses) and students' choice of A-levels (Sharp et al., 1996). The study was rated low/medium overall weight of evidence.

The study found no statistically significant relationship between setting by ability and A-level take-up for mathematics, chemistry or biology. Setting was found to be significantly related to higher take-up for physics in comprehensive and secondary modern schools.

Teaching time allocated to subjects pre-16 and post-16 subject choice

One study investigated the influence of the amount of teaching time allocated to subjects (i.e. for GCSE courses) and students' choice of A-levels (Sharp et al., 1996). The study was rated low/medium overall weight of evidence.

The study found that, whilst take-up of science A-levels (biology, chemistry, physics) was not significantly related to teaching time allocated for science pre-16, schools that had devoted a greater proportion of teaching time to mathematics in Year 10 tended to have significantly higher take-up for mathematics at A-level.

Advice and post-16 subject choice

One study investigated the influence of receiving various types of advice on students' A-level choices (Vidal Rodeiro, 2007). It was rated medium/high overall weight of evidence.

The relationship between advice and subject choice was investigated for both mathematics/science subjects and modern foreign languages.

Table 6.24: Advice and post-16 subject choice

Study	Subject	Compared to students receiving no advice, were those who received advice more (>) or less (<) likely to choose the subjects listed?												
		All types of advice	Parents	Brothers and/or sisters	Teachers	School leaflets	Other students/friends	University admission tutors	Speakers from higher education	Speakers from employment	Open day/careers events	Internet	Guidance at the centre	Interview at the sixth form centre
Vidal Rodeiro (2007)	Science /maths	<	>	<	<	<	<	>*	<*	<	<	>*	<	<
Vidal Rodeiro (2007)	Modern foreign languages L	<	>	<	>	>	<	<	>	<*	>	>	>	<

* p≤0.05

Although there was no effect for advice 'as a whole', some statistically significant relationships were found for different sources of advice that students acknowledged receiving.

Other factors and post-16 subject choice

Sharp et al. (1996) investigated a number of other school/college characteristics for which no significant relationships were found (for example, the relationship between subject choice and the requirement made in some schools/colleges that students studying science A-levels also took A-level mathematics). In addition, some statistically significant relationships were found for which the school/college characteristic (e.g. the size of A-level teaching groups) was probably the result of the higher take-up, rather than a cause of it. For further information, see the study results section in Appendix E.

6.3 Reasons for subject choices

6.3.1 Introduction

As outlined in section 6.1, a second group of studies took a different approach to answering the in-depth review question. In slightly different ways, these studies sought to determine students' reasons for the subject choices that they made.

In total, 21 studies/sub-studies of this type were reviewed in depth (Bewick and Southern, 1997; Brown et al., 2008; Cleaves, 2005; Curry et al., 1994; Darling and Glendinning, 1996; Gallagher et al., 1996; Gillibrand et al., 1999; Havard, 1996; Hendley et al., 1996; Jarman et al. 1998; Johnson, 1999; Matthews and Pepper, 2007; McCarthy and Moss, 1990; Mendick, 2006, Munro and Elsom, 2000; Reid and Skryabina, 2002; Sears, 1997; Springate et al., 2008; Tebbutt, 1993; Vidal Rodeiro, 2007; Wikeley and Stables, 1999). Six studies examined influences on choice of Key Stage 4 subjects. Eighteen studies explored post-compulsory subject choices.

The remainder of this chapter is arranged as follows: reasons for Key Stage 4 (or equivalent) subject choices (6.3.2); reasons for post-16 subject choices (6.3.3); and school staff views about what influences students' decisions (6.3.4).

6.3.2 Reasons for Key Stage 4 subject choices (14-16 years)

Overview

Six studies explored reasons given by pupils for their Key Stage 4 (or equivalent) subject choices. Five of the six studies were judged as low overall weight of evidence and one study rated low/medium.

Although 14-16 year olds arguably have fewer options open to them than do older students, they do have some choice as to what to study (see section 1.5). Tables presented in Appendix D illustrate the range of reasons given by pupils for their subject choices that were derived from the studies (table D.4) and gender differences in the reasons young people gave for their choices (table D.5).

Taking subjects at KS4

The study by Darling and Glendinning (1996) found that, across a wide range of subjects, pupils regarded their own views to be of primary importance, whereas the influence of parents and school staff on decision-making was seen to be of less significance. In the majority of subjects, boys and girls were found to be equally likely to feel that their views were of primary importance, although gender differences were found within specific subjects, including biology. Sixteen subjects in total were included in the analysis (for further details of both gender and subject-related differences in the reasons given by young people, see tables D.4 and D.5 in Appendix D).

Four of the remaining studies found that the most common reasons given by students for choosing certain STEM subjects were that they considered them to be useful for their future, especially in relation to future careers, and that they enjoyed them (Hendley et al., 1996; Jarman et al., 1998; McCarthy and Moss, 1990; Reid and Skryabina, 2002).

The final of the six studies (Wikeley and Stables, 1999) found a number of statistically significant gender differences in the reasons students gave for the subject choices made at this age. It was reported that boys were more likely than girls to choose 'double award' science or technology because of the perceived usefulness of these subjects; girls were found to be more likely than boys to say that they had chosen technology because of the nature and content of the subject. For modern languages, girls were more likely than boys to choose this subject because it was useful and for the language itself. Hendley et al. (1996) also examined boys and girls separately and found that girls were less likely than boys to have said that they chose technology in order to get a job.

Not taking subjects at KS4

Hendley et al. (1996) also investigated the reasons given by students for not taking technology in Year 10 and found that the two most cited reasons were perceived lack of ability and dislike of the subject. The authors also reported that boys' views "seemed to hinge around their abilities in the subject, whereas girls were more concerned about what they would be doing in technology if they opted for it" (p. 26).

6.3.3 Reasons for post-16 subject choices

Overview

In total, 18 studies explored reasons for post-16 students' subject choice decisions. Of these, one study focused solely on young people who had decided not to pursue a subject beyond the end of compulsory education. Table D.1 in Appendix D presents an overview of the studies, including details of the subjects investigated. Further tables (D.6 to D.11) accompany the information in the remainder of this chapter and are referred to in the text.

Taking STEM subjects post-16

Sixteen studies investigated young people's motives for *taking* particular subjects. Of these, four studies used questionnaires which were designed to elicit what students perceive as the most important influences on their subject choices (Bewick and Southern, 1997; Havard, 1996; Gallagher et al., 1996; Vidal Rodeiro, 2007). Of these, three presented young people with a set of possible influences and asked them to rank them in order of importance using Likert-type scales (for example, ranging from 'not at all important' to 'very important'). In the study by Bewick and Southern (1997) participants were presented with a list of five options and asked to identify the main reason for their choice of A-level subject. The approach taken in 11 studies involved asking young people an open-ended question about their reasons for pursuing particular subjects post-16, with the author(s) calculating the most frequently occurring responses (usually presented as percentages) and/or reporting qualitative findings (Cleaves, 2005; Curry et al., 1994; Jarman et al., 1998; Johnson, 1999; Matthews and Pepper, 2007; McCarthy and Moss, 1990; Mendick, 2006; Munro and Elsom, 2000; Reid and Skryabina, 2002; Sears, 1997; Springate et al., 2008; Tebbutt, 1993). Among this latter group of studies were some that involved in-depth questioning of young people.

Findings from the studies that collected students' own views about whom/what influenced them were extracted and are presented in table D.6 (see Appendix D). Whilst acknowledging some doubt over the suitability of comparing the results of studies that have used different methods and/or tools to assess young people's motives for choosing particular subjects, table D.6 nonetheless illustrates where there are variations between the studies and/or subjects in terms of the reasons given by young people for their subject choices.

When asked for their opinions, the students who were studied give a variety of reasons for their decisions to pursue certain STEM subjects after the end of compulsory education. The evidence suggests that usefulness of subjects is perceived by as the main reason; enjoyment and perceived ability also appear to be major influences.

Perceived usefulness of subjects: Six studies judged as medium overall weight of evidence found that students considered this to be an important influence on their selection of post-16 areas of study (Gallagher et al., 1996; Matthew and Pepper, 2007; Mendick, 2006; Munro and Elsom, 2000; Springate et al. 2008; Vidal Rodeiro, 2007). This was a relatively broad category capturing views about the utility of subjects in relation to future career prospects, entry requirements for further/higher education, or life in general. In the study reported by Vidal Rodeiro (2007), a ranking exercise was conducted and the most important influence on students' decision-making, according to the young people who took part, was usefulness of the subject. The study reported in Cleaves (2005), also medium overall weight of evidence, examined 'why' and 'how' higher-achieving pupils chose science at A-level. The results from this qualitative enquiry supported findings from other studies about the importance of pupils' self-perceptions. The study found that pupils who committed to a science career at an early age made a clear choice of taking the science subjects necessary for their chosen future career. A number of lower quality studies also highlighted the importance of perceived usefulness of subjects in young people's choices (Bewick and Southern, 1997; Curry et al., 1994; Jarman et al., 1998; McCarthy and Moss, 1990; Reid and Skryabina, 2002). Curry et al. (1994) conducted a qualitative investigation of the role of work orientation on subject choice, a concept believed to play a crucial role in motivation. The study found that girls who were categorised as 'careerist', defined as working full-time most of their married life, were twice as likely as 'non-careerists' to study science-only or science-dominant subjects.

Perceived ability: Four medium quality studies (Gallagher et al., 1996; Matthews and Pepper, 2007; Springate et al., 2008; Vidal Rodeiro, 2007) found that young people viewed their ability in the subject as a major influence on whether or not they elected to take certain subjects beyond GCSE. Views about ability were expressed in terms of 'being good at a subject' or an expectation of doing well in a subject. For some participants, views about ability were based on previous success at GCSE. Four lower quality studies also found that ability-related reasons were regarded as a main influence on subject choice (Bewick and Southern, 1997; Jarman et al., 1998; Reid and Skryabina, 2002; Tebbutt, 1993).

Enjoyment: Four studies of medium overall weight of evidence found that enjoyment of subjects was regarded by students to be a main influence on their choice of subjects (Matthews and Pepper, 2007; Mendick, 2006; Springate et al., 2008; Vidal Rodeiro, 2007). A further two studies of lower quality also found this to be a main reason for the choices students made (Jarman et al., 1998; Reid and Skryabina, 2002).

Combining subjects: The importance of choosing subjects that complement one another was raised by young people in two reviewed studies; medium/high and medium overall weight of evidence, respectively (Johnson, 1999; Matthew and Pepper, 2007). Students held the view that taking all science A-levels was more useful and/or acceptable than taking a combination; according to one student who was interviewed in-depth on this issue, "it was either all or nothing...a mixture wasn't really much use to anybody" (Johnson, 1999, p. 121).

Interest: One medium quality study (Munro and Elsom, 2000) found that this reason was viewed by students as a main influence on their decisions to continue with science subjects after the end of compulsory schooling. A further five studies judged as lower overall weight of evidence also found that interest was frequently cited by students (Bewick and Southern 1997; Havard, 1996; Jarman et al., 1998; McCarthy and Moss, 2000; Reid and Skryabina, 2002; Tebbutt, 1993).

While the evidence in table D.6 (Appendix D) suggests that parents/other family members were not viewed by young people as major influences on their subject choice decisions, it is important to note that the majority of the studies that presented students with a list of potential reasons did not include this item as a choice. Findings from qualitative interview data reported by Johnson (1999) lend further support for caution on this issue. In-depth interviews revealed that although the majority of students stressed their autonomy in making decisions about subject choices, parents were nevertheless acknowledged as being an important source of advice, information and support.

Not taking STEM subjects post-16

Seven studies investigated students' *rejection* of mathematics and/or science subjects for study post-16 (Brown et al., 2008; Gillibrand et al., 1999; Havard, 1996; Jarman et al., 1998; Johnson, 1999; Matthews and Pepper, 2007; Munro and Elsom, 2000).

Six studies asked young people directly for their reasons for not pursuing particular subjects; relevant findings from these studies are recorded in table D.7 (Appendix D). Two studies attempted to establish a statistical relationship between students' attitudes to subjects and their subsequent behaviour (i.e. subject choice decisions) (Brown et al., 2008; Gillibrand et al., 1999; these results are not shown in table D.7).

The evidence presented in table D.7 (Appendix D) indicates that students gave a number of different reasons for not taking certain STEM subjects beyond GCSE and suggests that the difficulty of these subjects is viewed as the main deterrent.

Perceived difficulty: Three medium quality studies found that perceived difficulty of the subjects was a main reason given by young people for not taking mathematics/ science subjects for advanced study (Brown et al., 2008; Johnson, 1999; Matthew and Pepper, 2007). Highlighting the emotive rejection of mathematics by some students, the study by Brown et al. (2008) quoted students who would rather die than take this subject at A-level. Matthew and Pepper (2007) also suggested a link between students' concern about struggling with the level of difficulty of certain A-level courses (despite having good GCSE grades) and the belief that it was harder to gain good A-level grades in certain STEM subjects than it was in other subjects. Johnson (1999) reported qualitative evidence from in-depth interviews with students who had originally intended to take science A-levels, but had gone on to take non-science subjects. Confirming the author's findings from questionnaires used in the earlier phase of the study, these students also gave difficulty of science as their reason for rejecting it after GCSE. The results of a further two studies (low and low/medium overall weight of evidence) corroborate the findings from higher quality studies (Havard, 1996; Jarman et al., 1998). Additional support came from a second relevant analysis conducted by Brown et al. (2008). This found a weak positive correlation between 'ease of mathematics' in school and intention to participate in A-level mathematics (i.e. the more difficult students found mathematics, the lower the participation); however, the effect was non-significant.

Perceived lack of ability: One study (medium overall weight of evidence) found that perceived lack of ability was a reason commonly given by students in explanation of their dropping mathematics after GCSE (Matthews and Pepper, 2007). In support of their 'comfort/utility hypothesis', the authors argued that young people's concern about the difficulty of these subjects at A-level was often linked to an expression of lack of confidence in their ability to tackle A-level, even, in some cases, by students who had achieved well at GCSE. Two studies (Gillibrand et al., 1999; Brown et al., 2008) used statistical approaches to investigate the influence of confidence/anxiety levels on students' A-level subject choices (low/medium and medium overall weight of evidence, respectively). Gillibrand et al. (1999) found that none of the students with the lowest measured confidence proceeded to take A-level physics. Brown et al. (2008) found that higher levels of student anxiety correlated with lower participation in mathematics, although the effect was close to zero and non-significant. Jarman et al. (1998) also found that students commonly cited lack of ability as an influence on subject choice (low/medium overall weight of evidence).

GCSE classroom experience: One study judged medium overall weight of evidence (Munro and Elsom, 2000) found that most of the interviewed Year 11 students who planned not to take science subjects beyond GCSE said they had decided by the end of Year 10, based mainly on their experience of science in the classroom.

Lack of interest/enjoyment: One study (medium overall weight of evidence) found that when asked why they had dropped mathematics after GCSE, many participants answered that it was dull, boring or uninteresting (Brown et al., 2008). This study also used correlational analysis to investigate the influence of this factor. After correcting for distribution of attainment, it found strong and significant positive correlations between the extent to which students liked or enjoyed mathematics in school and intention to participate in A-level mathematics. The study by Havard (1996) also found that level of interest in the subject was ranked as the most important factor by students who had taken no science A-levels (low overall weight of evidence).

Not useful: One study (medium overall weight of evidence) found that the response that mathematics was not useful for their future careers or education was also frequently given by students as a reason for dropping it after GCSE (Brown et al., 2008).

Gender differences in young people's reasons for their post-16 STEM subject choices

Seven studies explored gender differences in young people's reasons for their post-16 subject choices in relation to the study of mathematics and/or science subjects (Bewick and Southern, 1997; Brown et al., 2008; Gallagher et al., 1996; Jarman et al., 1998; Johnson, 1999; Matthew and Pepper, 2007; Mendick, 2006).

Although the studies took a number of different approaches to this issue, there were sufficient similarities to enable comparison (see table D.8, Appendix D). Each study explored whether boys and girls gave the same reasons for their post-16 subject choices, and/or whether they agreed on the importance of these reasons.

The studies provided mixed evidence about which sub-group (boys or girls) were more likely to cite any particular reason as an influence (or rate it more highly). Four studies of at least medium overall weight of evidence found that girls tended to be more likely than boys to give interest/enjoyment as a main reason for *taking* mathematics/science subjects (Gallagher et al., 1996; Johnson, 1999; Matthew and Pepper, 2007; Mendick, 2006). Matthew and Pepper (2007), for example, found that girls were twice as likely as boys to say that they chose mathematics because of their enjoyment of the subject. One lower quality study (Bewick and Southern, 1997) also found that girls were more likely than boys to say they had chosen mathematics because they were interested in it. Two studies of at least medium overall weight of evidence found that boys were more likely than girls to say that they were motivated to take mathematics/science subjects by a belief that these subjects were easy (Gallagher et al., 1996; Johnson, 1999). Similarly, Brown et al. (2008) found that girls were more likely than boys to cite difficulty as a reason for *discontinuing* with mathematics (medium overall weight of evidence). In the study conducted by Mendick (2006), male students were found to dominate the employment-related category, ‘to prove something to others’, whereas the category ‘to prove something to themselves’ was entirely female (medium overall weight of evidence).

School type differences in young people’s reasons for their post-16 STEM subject choices

Two studies investigated whether the type of school that young people attended influenced their views about whom/what had influenced their choice of science/mathematics subjects taken at A-level (Gallagher et al., 1996; Johnson, 1999).

Only one reason was investigated by both studies (see table D.9, Appendix D). Both studies (medium/high and medium overall weight of evidence) found that different levels of importance were given to ‘teachers/school staff’ by students in co-educational schools and students educated in single-sex schools, with the former tending to view it as more of an influence.

Grade-related differences in young people’s reasons for their post-16 STEM subject choices

One study, rated medium overall weight of evidence, investigated grade-related differences in young people’s reasons for not continuing with mathematics at A-level (Brown et al., 2008). Predicted GCSE grades, which would have been available to students when they were asked about the subjects they intended to study at A-level, were used in the analysis. The study found that many of the reasons given for not continuing with mathematics were grade-related. For example, students with predicted B and C grades were found to be more likely than students with predicted A/A* grades to say that they intended to drop mathematics after GCSE because of the difficulty of the subject. The authors also report that there was some evidence of high attaining girls lacking in confidence in their ability to successfully tackle advanced study in mathematics.

Social class differences in young people’s reasons for their post-16 STEM subject choices

One study, rated medium overall weight of evidence, explored social class differences in young people’s reasons for not continuing with mathematics at A-level (Mendick, 2006).

The study found that more middle class students (86 per cent) than working class students (36 per cent) chose mathematics because they enjoyed it; more working class students (32 per cent) than middle class students (5 per cent) chose it to prove something to others.

GCSE science course background differences in young people’s reasons for their post-16 STEM subject choices

One study explored differences in the reasons that students from different science course backgrounds gave for taking and not taking science at A-level (Sears, 1997). It was rated low overall weight of evidence.

The study found that there were two significant differences between students from a GCSE ‘double award’ science background and others over why they chose their A-levels. ‘Double award’ students were more likely than students from other science backgrounds to indicate that they were pursuing science at A-level for career reasons.

More ‘double award’ students said they were attracted by potential salaries in science jobs. However, this group were also more likely than students from other science backgrounds to say they were put off A-level science by their lack of enjoyment at GCSE. Many students from a physical science background also said they had chosen science at A-level for career reasons.

Subject-related differences in young people’s reasons for their post-16 subject choices

Five studies explored subject-related differences in young people’s reasons for their post-16 choices (Curry, 1994; Gallagher et al., 1996; Johnson, 1999; Sears, 1997; Vidal Rodeiro, 2007).

A medium/high weight of evidence study (Johnson, 1999) compared students’ reasons for choosing mathematics, physics, computing and English literature, and it was reported that, on the whole, overall ratings of importance for the different reasons did not vary much between the four subjects examined. In a separate analysis, students were asked why they had rejected subjects; among participants were those who had not pursued subjects that they had earlier expressed an intention of taking. Based on responses to a questionnaire, the study found that, where some non-STEM subjects were concerned, students gave different reasons to those used to explain rejection of science-related subjects (see table D.6, Appendix D). For English literature and psychology, restricted options offered by the school/college were the reasons most frequently given by students for not taking their preferred subjects. Qualitative evidence from in-depth interviews conducted as part of this study further suggested that this was an issue. In-depth analysis also highlighted the importance that some students attached to taking subjects that complemented one another. Examples were reported of students rejecting history and French because of a perception that it was more useful to take three science A-levels.

Vidal Rodeiro (2007) rated medium overall weight of evidence, also investigated the reasons given by students for their selection of a number of different subjects. In subjects such as physics, chemistry, mathematics, business studies, English and accounting, usefulness for a future career featured as the most important reason. This reason also featured strongly in relation to law, economics, Spanish, physical education, and health and social care. For many other subjects, responses relating to interest and enjoyment outnumbered those relating to ability or usefulness for a career. Subjects were also grouped into five areas, and the study revealed differences between subject areas, such as the contrast between the sciences and the arts (see table D.6, Appendix D). For students choosing the arts, enjoyment and interest in the subject were ranked as more important than usefulness (e.g. for admission to higher education and/or future employment). For students choosing science/mathematics subjects, usefulness was ranked as the most important influence.

Three further studies also investigated subject-related differences in students’ motives for choice of A-level subjects. Gallagher et al. (1996), rated medium overall weight of evidence, found some statistically significant differences between the reasons given by science, arts and ‘mixed’ (i.e. those who took both sciences and arts) students. For example, whereas science students emphasised higher education, future careers and that the subjects will lead to a well paid job, arts students placed greater importance on the A-level being an easy option and the most interesting. The study by Curry (1994) likewise found that girls who were categorised as ‘careerists’ were more likely than ‘non-careerists’ to study science-related subjects, with ‘non-careerists’ more likely to study arts or arts-dominated subjects (low weight of evidence). It was reported by

Sears (1997) that students who chose arts A-levels were more likely to say that they had been influenced by friends (low weight of evidence).

6.4 Teachers' views of the factors which encourage/discourage take-up of subjects?

Overview
Two studies explored teaching staff views about the factors influencing take-up of mathematics and science subjects post-16 (Matthew and Pepper, 2007; Sharp et al., 1996). They were rated medium and low overall weight of evidence, respectively.

Factors which encourage take-up of STEM subjects post-16
Sharp et al. (1996) found that heads of departments believed there to be a number of different reasons for students' decisions to take mathematics or science subjects at A-level (see tables D.10 and D.11, Appendix D). The main reasons, according to staff who were interviewed, were that students wanted to pursue a career or further study in these areas, liking/enjoyment of the subjects, previous achievement and the teacher's enthusiasm for the subjects. The research also found that heads of mathematics departments felt that girls were encouraged to take mathematics A-level if they had good female teacher role models and had experienced success in mathematics pre-16. Matthew and Pepper (2007) asked teaching staff how far they agreed with the theory that boys are motivated more by the usefulness of mathematics and girls by feelings of security (their 'comfort/utility' hypothesis). The research found that responses were split between those who tended to agree with the hypothesis and those who tended to disagree.

Factors which discourage take-up of STEM subjects post-16
Both studies also questioned staff about their views on the factors discouraging take-up of mathematics/sciences at A-level. Sharp et al. (1996) found that heads of departments tended to think that the main factors discouraging students from taking these subject post-16 were students' perception of these subjects as more difficult than other A-levels, and/or their experiences of greater difficulty in these subjects (as reflected in lower GCSE grades, for example). Some staff also rated low quality teaching and poor subject image as major influences on students' rejection of mathematics/science subjects. Several teachers interviewed by Matthew and Pepper (2007) suggested that the absence of coursework from A-level mathematics could be a reason why girls are not drawn to it.

6.5 Summary of in-depth review findings

6.5.1 Summary of studies included in the in-depth review

Twenty-five studies (in 46 reports) were included in the in-depth review. Reflecting the inclusion criteria, all studies were carried out in the UK. Seventeen studies analysed data from England and/or Wales.

Key Stage 4: 14-16 years (8 studies)

- Two studies were judged to be medium/high overall weight of evidence (WoE), and six were rated as low.

- Five studies analysed data from England and/or Wales, one from Northern Ireland and two from Scotland.
- STEM subjects investigated: science and/or mathematics (three studies), technology (five studies), and engineering (0 studies).
- Non-STEM subjects to which STEM participation was compared: modern foreign languages (two studies), computing (one study), office and information studies (one study), home economics (one study), music (one study), modern studies (one study), history (one study), art (one study), social and vocational studies (one study), geography (one study), psychology (one study), physical education (one study), social and environmental studies (one study), and creative and aesthetic studies (one study).

Post-16 (20 studies)

- Four studies were judged to be medium/high overall WoE, eight studies were rated medium, three studies rated low/medium, and nine studies rated low.[11]
- Fifteen studies analysed data from England and/or Wales, three from Northern Ireland, one from Scotland and one from the UK.
- STEM subjects investigated: science and/or mathematics (19 studies), technology (one study), and engineering (0 studies).
- Non-STEM subjects to which STEM participation was compared: English (two studies), modern foreign languages (one study), computing (one study), history (one study), psychology (one study), arts (one study), French (one study) and social sciences/humanities (one study).

6.5.2 Summary of synthesis

The studies addressed the in-depth review question in two different ways. *Factors* studies generally used large datasets on GCSE or A-level (or equivalent) subjects to explore associations between the subjects taken and various socio-demographic and educational characteristics. In most cases, *reasons* studies used approaches in which young people were asked about their reasons for making particular subject choices. The findings of the synthesis carried out as part of the in-depth review took into consideration the number of studies exploring each factor/reason, reported methodological quality and consistency of results. In summarising these findings, no interpretation was undertaken, or conclusions drawn, when a result was based only on lower quality studies (i.e. those rated low or low/medium overall weight of evidence). For studies designed to establish statistical relationships between variables, all findings from medium and medium/high studies had to point to the same conclusion in order to increase our confidence that a relationship between subject choice and the investigated factor existed.

A significant finding of the review is the lack of good quality research on this topic. Only 12 studies were judged as medium or higher overall WoE. Most potential factors were investigated in one study only and/or in lower quality studies. The following summary of the synthesis is based on these 12 studies only.

Factors investigated as potentially linked to students' subject choices (Key Stage 4 and post-16) for which insufficient evidence of a link was found

[11] Total greater than 20 as four studies used more than one method of analysis and these were weighted separately.

- Socio-economic status, subjects taken at GCSE, school/college size, school type (single-sex/co-educational), school type (comprehensive/grammar/etc), school type (independent/local authority), school type (with sixth-form/without sixth-form), school type (religious denomination), school status (degree of autonomy of school management), school/college academic attainment, qualifications of teaching staff, gender ratio of teaching staff, setting by ability, teaching time allocated to subjects pre-16, urbanicity, geographical setting, advice.

Based on the 12 studies judged as medium or higher overall WoE, the synthesis suggests the following:

Factors linked to Key Stage 4 (14-16 years) subject choices

- There is evidence of a link between students' subject choices relating to the study of science(s) at Key Stage 4 and (1) gender, and (2) ability. This link does not appear to be explained by other differences between students, such as socio-economic background or type of school attended.
- *Science subjects*: The following groups were found to be more likely to take i) separate GCSEs in physics, chemistry and biology, ii) 'double award' GCSE science when compared to 'single award' GCSE science, or iii) one or more science(s) from the 'scientific studies' mode (Scotland):
    - boys (two studies; medium/high WoE)
    - higher ability students (two studies; medium/high WoE).
- From the same cohorts of students, the following groups were found to be more likely to pursue modern foreign languages at Key Stage 4 (or equivalent):
    - girls (two studies; medium/high WoE)
    - higher ability students (two studies; medium/high WoE).

Factors linked to post-16 subject choices

- There is evidence of a link between students' post-16 science/mathematics subject choices and (1) ethnicity, and (2) ability. This link does not appear to be explained by other differences between students, such as socio-economic background or type of school attended.
- *Science/mathematics*: The following groups were found to be more likely to pursue science/mathematics subjects beyond the age of compulsory education:
    - Asian students (two studies; medium/high WoE)
    - students with higher GCSE grades (two studies; medium/high WoE).

Reasons for taking STEM subjects post-16

- The findings from the synthesis of nine studies (referring, between them, to mathematics, science, physics and chemistry) suggest that young people *perceive* the following to be the four main reasons for taking these subjects post-16:
    - usefulness (six studies; six medium WoE)
    - ability (four studies; four medium WoE)
    - enjoyment (four studies; four medium WoE)
    - complementary subjects (two studies; one medium/high, one medium WoE).

Reasons for not taking STEM subjects post-16

- The findings from the synthesis of six studies (referring, between them, to mathematics, science, physics and chemistry) suggest that young people *perceive* the following to be the main three reasons for not choosing these particular subjects post-16:
    - difficulty of subjects (four studies; one medium/high, three medium WoE)
    - lack of ability (four studies; two medium, two low/medium WoE)
    - lack of interest/enjoyment (two studies; two medium WoE).

Gender differences in reasons for post-16 STEM subject choices

- The findings from the synthesis of five studies (referring, between them, to mathematics, science and physics) suggest that:
    - girls are more likely than boys to give interest and/or enjoyment as a reason for their STEM-related subject choices (four studies; one medium/high, three medium WoE)
    - boys are more likely than girls to give easiness of the subject as a reason for their STEM-related subject choices (three studies; one medium/high, two medium WoE).

School-type differences in reasons for post-16 STEM subject choices

- The findings from the synthesis of two studies (referring, between them, to mathematics, science and physics) suggest that:
    - students in co-educational schools are more likely than those in single-sex schools to view teachers/school staff as an influence on their STEM-related subject choices (two studies; one medium/high, one medium WoE).

Chapter 7. Discussion and implications

7.1 Discussion

Based on the summary findings presented in section 6.5, it is argued that the available evidence establishes a link between a small number of factors and subject choice. This is not to say that other factors are not linked, only that the review did not find evidence to support such claims.

The use of the term ‘choice’ throughout the review should not be assumed to indicate acceptance of the idea that all students are completely free to choose whatever subjects they like. Even at post-16 level, choice may be constrained in many ways; students may only be superficially free to choose, or not free to choose at all (Woods, 1976; Stables, 1997).

7.1.1 Gender and subject choice

At Key Stage 4 (or its equivalent in Scotland), male and female students are likely to make different subject choices in relation to the study of science. Boys are more likely than girls to take GCSE ‘triple award’ science (i.e. separate GCSEs in biology, chemistry and physics); they are also more likely than girls to take at least one science subject when they have a choice about whether to do so or not. How much of this may be due to what the school offers, rather than student ‘choice’, remains unclear. Although only one study investigated the role of gender in post-16 choices, this still adds strength to the conclusion that male and female students make different subject choices that are not explained by systematic differences in ability, socio-economic, ethnic, or school organisational factors. Gender differences in subject choice were identified in reviews by Pollard (2003) and Murphy and Whitelegg (2006); the latter also outlined what it not known about why girls do not choose physics post-GCSE.

7.1.2 Ability and subject choice

At both Key Stage 4 and post-16, students with different levels of ability are likely to make different STEM subject choices, with those having higher levels of prior attainment (e.g. measured by examination grades) being more likely to continue their study of science/mathematics subjects. This difference in choice between ‘high’ and ‘low’ achievers does not appear to be explained by systematic differences in socio-economic, ethnic, gender or school organisational factors. This link between ability and subject choice was also identified in the recent review by Gorard and See (2008b).

7.1.3 Ethnicity and subject choice

The data in two studies suggest that ethnicity is a factor in subject choice. However, the construction of categories such as ‘Asian’ in these studies is problematic, as it treats as a homogenous group people who are from distinct socio-cultural and ethnic groups. Furthermore, it is not known if the same subgroups of individuals are included in the ethnic categories used by each study. As it is difficult to assess to what extent the constructed ethnic groups ‘match’, it is not clear how these findings should be interpreted. This issue is not limited to these studies alone, as identified in research by Bradby (2003) and Gunaratnam (2003).

7.1.4 Why these differences in subject choices, by gender, by ability?

Whilst it is important to be able to identify and confirm that certain STEM subject choices are linked to these two factors (gender and ability), this knowledge is insufficient for making decisions about policy and practice. For example, knowing that boys are more likely than girls, all things being equal, to choose to study STEM subjects does not really help in decisions about what, if anything, to do about it. What is necessary to understand is how and why they are linked.

The review includes evidence from students about why they made particular subject choices. The issues that were most commonly raised as important influences on whether or not STEM subjects were pursued beyond age 16 were the utility of the subject for future education or career purposes, enjoyment or interest in the subject, perceived ability in the subject, subject difficulty, and the importance of taking subjects that complemented one another. These reasons were also identified in previous reviews on this topic (e.g. Osborne et al., 2003; Pollard et al., 2003).

How do these reasons for selecting or not selecting subjects help to explain the differences in participation between boys and girls, or between students of different ability, found in the review? Answering this question is limited by two aspects of the literature analysed for this review. Firstly, whilst the synthesis of evidence from different sources increases confidence that the cited reasons are those perceived by young people as the most important influences on their decision-making, this type of evidence cannot establish if these reasons are the actual cause of their pursuit or non-pursuit of subjects. These are essentially opinions and need not necessarily be related to the behaviour that a pupil actually exhibits. Secondly, the studies that asked young people about the reasons for their subject selections did not usually analyse the data for different subgroups (e.g. by gender), so only limited insight can be gained on this question.

There is some evidence that girls are more likely than boys to give interest and enjoyment as a reason for their choice of certain STEM subjects, and some evidence that boys are more likely than girls to say that the easiness of the subject influenced them. Even if this were accepted as generally 'true', the question as to why such gender differences can be found remains unanswered.

Students' perceptions about their ability and subject difficulty also illuminate the link between prior attainment and subject choice. That high achievers are more likely than low achievers to continue with certain subjects is presumably evidence that the system is working as intended (i.e. we would expect students whose attainment grades indicate that they 'are better' at a particular subject to go on and study that subject at a higher level). There is some evidence that students with lower levels of prior attainment in STEM subjects (but who nonetheless have 'good' grades) perceive that they lack the ability to study the subject at a higher level and/or to do so will be more difficult than an alternative subject for which they perceive they have greater ability. This raises the question of what information and guidance is being offered to pupils when they are making their choices and the issue of relative subject difficulty and its bearing on student choices. Recent estimates of grade severity have been published by Coe and colleagues at the University of Durham who argue that STEM subjects at both GCSE and A-level are harder than most others, if by 'harder' it is meant that the same grade corresponds to different levels of general academic ability (Coe et al., 2008; see also Fitz-Gibbon and Vincent, 1997).

The prior attainment relationship could, however, be problematic in a number of ways. Firstly, if the measure of prior attainment is not an accurate and reliable predictor of ability to study at a higher level; secondly, if there are identifiable groups of students whose prior attainment in STEM subjects indicates they could study STEM subjects at a higher level but who 'choose' not to do so. The review found some evidence that this may be the case for girls. Also, given the link between socio-economic status, school type (i.e. independent schools) and attainment (see, for example, the recent review by Gorard and See, 2008b) and the claimed differences in the way that science is taught between schools, it may be that the organisation of the education system is discouraging pupils with appropriate prior attainment and/or ability from more disadvantaged backgrounds from studying STEM subjects at a higher level.

From the perspective of STEM education as a mechanism for training future scientists, engineers, technologists and mathematicians, the selection of STEM subjects for further study by those indicated to have the highest level of ability is clearly desirable, not only from the point of view of the individual, who is likely to be most successful in subjects for which they have proven aptitude, but also for society as a whole. The 'selection out' of STEM education of the large majority of students may be viewed as a different kind of problem, when viewed from the perspective of raising standards of scientific literacy more generally.

7.2 Limitations of the existing evidence base

There are a number of limitations in the design and conduct of the literature identified which limit the utility of the evidence base. One of the most striking findings of this review, given the level of interest in STEM education, is how little UK research has been carried out on the issue of factors influencing students' subject choices in these fields. The mapping exercise, which was designed to identify OECD literature on this topic but not restricted by subject area, identified a relatively large body of relevant empirical research (240 studies). Analysis revealed that much of this research was conducted outside the UK and/or it was not STEM-specific. Only 25 studies were identified as answering the in-depth review question. This seems to be remarkably few for a period covering 20 years and would not appear sufficient to understand this complex issue. Moreover, the quality of many studies was such that caution was required in interpreting the findings. Only 12 studies were judged to be of reasonable quality with respect to the review question; that is, had an overall weight of evidence of medium or higher.

Most of the research focused on students who had elected to take certain STEM subjects and thus was limited to an investigation of the factors that facilitated these choices; few studies explored barriers to the uptake of STEM subjects. Researching both of the relevant populations (those who pursue particular subjects further, and those who do not) seems critical to understanding this complex issue.

In addition, the focus of the research was unevenly distributed, in terms of the range of both the ages of young people who were investigated and subjects. The bulk of the studies explored post-16 subject choices. This was not surprising, given the review's focus on STEM subjects, and the limited choices that 14-16 year old students have in relation to the study of mathematics and science subjects. Furthermore, the research was mainly concentrated on just two STEM subject areas: mathematics and science(s). No studies investigated decisions about the study of engineering and few explored decision-making in relation to the study of technology. Although several studies collected data relating to both STEM and non-STEM subject areas, analyses of subject–related comparisons were often limited by the grouping of subjects into very broad categories, such as the arts. Only a small number of studies considered the views of teachers on this issue, and no research was identified which included parents in the study population.

Only one study focused on students specialising in STEM subjects, i.e. those who took two or more science/mathematics subjects. Since students taking a single science subject at A-level are generally prohibited from pursuing science in higher education or scientific careers, students choosing science subjects only post-16 (or science and mathematics) would seem to warrant closer investigation, certainly if the concern is with the nation's economic prosperity.

Consideration of the way the word science was used in a number of primary studies was also critical in the interpretation of the findings. Some researchers were found to have grouped individual science subjects together in a single analysis and reported their findings as if referring to a single subject; others conducted separate analyses but reported many, if not all, of their findings using the term science. Generalising about people who choose to study science - treating them as a homogenous group - assumes that students who study the different science subjects share a similar profile, and therefore that the factors responsible for their selection/non-selection of subjects are also similar. It is worth questioning whether this is appropriate. If the profile of students who study the different science subjects is dissimilar, the factors influencing their subject choice decisions may also be quite different. Using the term science inappropriately has the potential to mask any underlying differences between subjects.

Although some of the studies included a considerable amount of data, often only a small section of the study dealt specifically with the issue of subject choice. A lack of consistency in approaches (for example, in investigating the same factors using different datasets or using similar methods for gaining young people's perceptions) also meant that only limited evidence was available for synthesis. Furthermore, although a long list of factors have been investigated, in many cases this was by only one study.

It might also be argued that the characteristics of the existing research are insufficient to understand the dynamics of choice. Studies were typically cross-sectional in design; often small in scale, and thus subject to restrictions on their generalisability, and/or limited by the constraints of existing data (where secondary data analysis was used). Several of the studies taking a statistical approach to this investigation did not control for confounding variables, thereby reducing the validity of any findings. The general lack of large-scale longitudinal studies amongst those that were reviewed means that the evidence base for understanding the decision-making process is not strong. Longitudinal studies following young people over a period of time are arguably better suited to understanding the subject choice decision-making process, as they avoid some of the problems associated with asking young people to make retrospective judgements and offer greater potential for capturing the different routes by which final choices are reached. Such studies are more feasible than in the past. Firstly, because of the growth and consolidation of longitudinal cohort studies of children and young people in the UK. The recently available Longitudinal Study of Young People in England dataset, which brings together data from a number of sources, including annual interviews with young people and their parents/carers, is an important part of this.[12] Secondly, because of the development in, and linking of, large-scale, individual-level administrative databases, such as the Pupil-Level Annual School Census/National Pupil Database (PLASC/NPD) and Higher Education Statistics Agency/Universities and Colleges Admissions Service (HESA/UCAS) datasets. Recent research in this field highlights the possibilities of using this type of data (Gorard and See, 2008a; Vignoles and Powdthavee, 2009). A potential model for longitudinal research on student participation is the approach used by researchers currently involved in a project aimed to better understand how to extend and improve learning in mathematics (Hernandez-Martinez et al., 2008).

[12] http://www.esds.ac.uk/longitudinal/access/lsype/L5545.asp

A further complicating factor is that the findings emerging from some of the literature analysed for the review are based on data collected in the 1990s. The applicability of the findings of such studies to current contexts may be questioned. Considerable changes have taken place in the socio-economic, cultural, general educational and STEM-specific educational landscape over the last 10-20 years; for example, the widening of the post-16 curriculum offer and the introduction of AS qualifications following Curriculum 2000. It remains unknown what effects, if any, such changes may have had on students' choice of subjects.

The published research reviewed here indicates a lack of coordinated research that replicates and/or extends findings from previous research. It might be that this is partially a result of the dispersed and fragmented nature of the field, the issue being of interest and relevance to a wide range of agencies and individuals within and without the STEM community.

7.3 Strengths and limitations of this systematic review

The methods used in this review and the comprehensiveness of the reporting ensure that the review process is transparent, replicable, updateable and expandable in known ways. They also ensure that the quality of the primary studies is taken into account in the synthesis and interpretation of the results. The involvement of the Wellcome Trust at all stages of the review helped to ensure that the review remained focused on the questions being addressed, although the authors take full responsibility for all content of the review.

The use of a two-stage model produced a map that is a useful product in its own right and creates a database of studies that facilitates sustainability and the potential for development of a cumulative knowledge base in this field.

A further strength of this review is that it conducted comprehensive searches of a wide range of electronic bibliographic databases. Strategies were also employed to increase opportunities for identifying non-indexed (grey) literature, including searches of websites of relevant stakeholder organisations in the UK and other OECD countries, contact with experts, and scanning reference lists. Despite these supplementary approaches, in the later stages of the review a number of studies were identified serendipitously which are relevant to this review question, but were not included in the analysis (including Bevins et al., 2008; Elias et al., 2006; Gorard and See, 2008a; Secondary National Strategy, 2008; Smart and Rahman, 2009). It is not entirely clear why this happened, although it may be due to one or more of the following: missing search terms; handsearching being too limited and/or insufficiently focused on UK sources; reference checking (of a selection of relevant reviews and of included studies at the in-depth review stage) being done on title only; additional searches for relevant literature published post October 2008 not being conducted. There is potential that the findings of these recently identified studies, if incorporated into the review, may alter the conclusions.

Any systematic review can only be as good as the amount and quality of primary research that is included in it. The main limitation of the review was the scarcity of high quality UK-based research evidence in the area in which the in-depth review focused.

The scope of the in-depth review was restricted specifically to UK studies of STEM subject choices. For this reason, studies of post-16 participation more broadly (e.g. those concerned with students' decisions about whether to stay on in education) were not part of the remit of this review, nor were studies about attitudes to subjects and/or career choices.

Inclusion in the review was restricted to studies published in the English language. It is unknown how many relevant studies are published in languages other than English.

7.4 Implications

The review has implications for a range of stakeholders, including policy makers and the broader research community.

7.4.1 Implications for policy

Given the limitations of the review and the evidence contained therein, caution is required when considering what implications the findings of this review have for policy and practice in this area. The evidence would not appear to be strong enough to recommend directions for new policy or practice initiatives.

Nonetheless, this is an area that policy needs to look at carefully in its planning. One suggestion for moving forward is to look at the outcomes of relevant studies that are currently underway. A key opportunity is presented by the recent Economic and Social Research Council (ESRC) and Department for Children, Schools and Families (DCSF) funded programme which has invested £3 million as part of a commitment to finding new ways to encourage greater student participation, engagement, achievement and understanding of science- and mathematics-related subjects. Five projects across the UK have been funded to address a number of key research challenges relating to science/mathematics education.[13]

Where initiatives are currently in the process of being designed, those involved may wish to reflect on the extent to which they have considered students' enjoyment, their views about the usefulness and difficulty of subjects, the role of prior attainment in young people's decision-making and the extent to which any proposed initiative creates equal opportunities for studying STEM subjects.

It may also be useful to reflect more generally on the potential tensions created in the educational system as a result of trying to meet the parallel goals of greater scientific literacy for all and producing the scientists, technologists, engineers and mathematicians of the future. Linked to this is the question of whether policy interest in STEM overlooks key differences between subjects in terms of their structure, priorities and challenges. It may be more fruitful for the STEM components to be considered separately, rather than as a block.

7.4.2 Implications for the research community

One of the aims of this review was to highlight potential research directions suggested by the current evidence base in this area. To improve the quality of the evidence and increase understanding of the determinants of student subject choice, the following suggestions are proposed:

Secondary research:

- Commissioners of research should consider updating the findings of this review, to include the additional studies we have identified.

[13] http://www.esrc.ac.uk/ESRCInfoCentre/PO/releases/2008/may/investment.aspx

- Future research may wish to explore additional areas of the systematic map; for example, undertake a synthesis of intervention studies, building on those identified during the mapping phase of the review.
- Future reviews of the broader related literature may provide useful evidence for policy and practice in this area. Potential reviews might include those in the areas of post-16 participation more broadly, or those that investigate attitudes to subjects or career choices. Making these connections would complement the findings of this review.
- Researchers conducting systematic reviews in a similar field may want to consider devoting more time in search strategies for searches for relevant grey literature.

Primary research:

- Commissioners of research should consider commissioning longitudinal studies in this area.
- Researchers undertaking longitudinal studies may wish to explore a more rigorous and nuanced understanding of student subject choice. For example, studies should have sufficient breadth (i.e. across subjects and across the UK), and depth (i.e. including the views and experiences of students, parents and teachers regarding subject choice, and observations of actual teaching practices and pupil response).
- Research should be undertaken on the individual science subjects separately (e.g. biology, chemistry, physics), and should avoid the use of 'science' in a single analysis.
- Research should be undertaken on the factors influencing young people's choice/non-choice of engineering.
- Those not taking science should be routinely used in studies as a comparison.
- Research in this area should differentiate between STEM specialists and those pursuing mixed A-levels.
- Consideration should be given to the commissioning of a new programme of research, and/or coordination of an existing one, involving major stakeholder groups in the area of subject choice. This would have the potential to play a major role in shaping the development of a cumulative knowledge base, by developing and using standardised instruments/ techniques and common reporting standards. A coordinated approach could ensure that the range of studies were of a sufficient scale and coherence to support policy and practice.

The Wellcome Trust would, for a variety of reasons, appear to be ideally situated to initiate a dialogue between the major stakeholders on the possibility of such a programme. The ESRC/DCSF funded programme discussed earlier may present a suitable opportunity.

Appendix A: Search strategy

Bibliographic databases:

ERIC (CSA)

Australia Education Index (Dialog Datastar)

British Education Index (Dialog Datastar)

PsycInfo (EBSCO)

International Bibliography of the Social Sciences (EBSCO)

Applied Social Sciences Index and Abstracts (CSA)

Conference Papers Index (CSA)

Websites:

Engineering and Technology Board http://www.etechb.co.uk/

Institute of Employment studies http://www.employment-studies.co.uk

National Foundation for Educational Research http://www.nfer.ac.uk/index.cfm

Department for Children, Schools and Families http://www.dcsf.gov.uk

Ministries and/or Departments of Education for 27 of the 30 OECD countries (see below). Those for Austria, Italy and Mexico could not be searched - either because a working link could not be found, or the website was not in the English language.

Australia	http://www.dest.gov.au
Belgium	http://www.vlaanderen.be/onderwijs/
Canada	http://www.edu.gov.on.ca/; http://www.mels.gouv.qc.ca/
Czech Republic	http://www.msmt.cz/
Denmark	http://eng.uvm.dk/
Finland	http://www.minedu.fi/OPM/
France	http://www.education.gouv.fr/
Germany	http://www.bmbf.de/en/index.php
Greece	http://www.ypepth.gr/
Hungary	http://www.okm.gov.hu/
Iceland	http://eng.menntamalaraduneyti.is/
Ireland	http://www.education.ie/
Japan	http://www.mext.go.jp/english/
Korea	http://english.mest.go.kr/
Luxemburg	http://www.men.public.lu/index.html
Netherlands	http://www.minocw.nl/english/index.html
New Zealand	http://www.minedu.govt.nz/
Norway	http://www.regjeringen.no/en/dep/kd.html?id=586

Poland	http://www.poland.pl/education/
Portugal	http://www.min-edu.pt/np3/destaques
Slovak Republic	http://www.minedu.sk/index.php?lang=en
Spain	http://www.mepsyd.es/educacion.html
Sweden	http://www.sweden.gov.se/sb/d/2098
Switzerland	http://www.sbf.admin.ch/htm/index_en.php
Turkey	http://www.meb.gov.tr/english/indexeng.htm
UK	http://www.dcsf.gov.uk/index.htm
USA	http://www.ed.gov/index.jhtml

Citation checking:

McCrone T, Morris M, Walker M. Pupil choices at key stage 3: literature review. Slough: National Foundation for Educational Research; 2005.

Moon S, Lilley R, Morgan S, Gray S, Krechowiecka I. A systematic review of recent research into the impact of careers education and guidance on transitions from Key Stage 3 to Key Stage 4 (1988–2003). In Research Evidence in Education Library. London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London; 2004.

Murphy P, Whitelegg E. Girls in the physics classroom: a review of the research on the participation of girls in physics. London: Institute of Physics; 2006.

Obsorne J. Attitudes towards science: a review of the literature and its implications. International Journal of Science Education 2003; 25(9): 1049–1079.

Pollard E, Jagger N, Perryman S, Van Gent M, Mann K. Ready, SET Go: a review of SET study and career choices. London: Engineering Technology Board; 2003.

Wright S. The health of subjects: evidence from examinations entries. Nuffield Foundation; 2006.

Appendix B: The scope of the map

Population: The scope of the map extends to young people aged 11-19 years in education (secondary schools and post-16 settings, such as sixth-form colleges). Studies that do not include students in this age group in their samples, but include other relevant stakeholders (e.g. parents or teachers) are also within the scope of the map, if the data that is collected refers to students of the appropriate age.

Topic: To be considered relevant to the map, studies must focus on decision-making in relation to students' subject choices (both subject selection and subject rejection). This is further conceptualised as follows:

> **Non-evaluative research evidence:** To be within the scope of the map, studies must explore the relationship between one or more variables (e.g. gender, enjoyment, timetabling constraints) and decision-making in relation to subject choices. Therefore, studies that are concerned with attitudes to different subjects - but not in relation to young people's decision-making about subject choices - are outside the scope of the review. The sole focus is on secondary schooling (or post-compulsory equivalents, such as sixth-form colleges). Outside the scope of the map are studies that explore factors associated with subject choices made at events such as summer schools or science clubs.
>
> **Evaluative research evidence**: To be within the scope of the map, the evaluated intervention must aim to influence young people's subject choice decisions, or this must be one of the outcomes measured in the study.

At the mapping stage, the core interest is in the decision-making process and therefore all subjects (i.e. not only STEM) are considered to be relevant. For the purposes of this review, positive intentions are hypothesised to predict actual behavioural decisions to participate, therefore studies investigating influences on planned/intended choices are within the scope of the review. While acknowledging that examination entry is an imperfect proxy for subject choice, this data can nevertheless give a useful indication of changing patterns of decision-making among students, therefore studies using this type of data are also within the scope of the review.

Intervention type: A wide range of intervention types are within the scope of the map, including evaluations of educational policy changes (for example, reforms to the subject choice process or modifications to the curriculum/syllabus content or assessment arrangements). One type of intervention is outside the scope of the map: teacher training.

Outcomes measured: The key outcome measure is subject choices (or terms to that effect), including behavioural intentions in relation to subject choices. Studies are also within the scope of the map if they have measured proxy outcomes, such as attitudes to, or preferences for, different subjects, providing the outcome refers specifically to individual school subjects. Studies that, for example, have evaluated the economic effects of interventions or attitudes towards the decision-making process itself are therefore outside the scope of the map.

Geographical coverage: Both UK-based and international evidence is within the scope of the map. It is restricted, however, to studies conducted within the 30 countries that are members of the Organisation for Economic Co-operation and Development (OECD). These countries are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States. Both comparative and single-country studies are eligible for inclusion.

Date: Only those studies published 1988 onwards are within the scope of the map. In 1988, the National Curriculum was established by the Education Reform Act and defines the minimum educational entitlement for pupils of compulsory school age. Since its introduction, students have been required to study three core subjects of English, mathematics and science, supplemented with non-core foundation subjects. It applies to pupils in community and foundation schools, including special schools and voluntary aided and voluntary controlled schools.

Language: The map is restricted to studies published in English, as there are insufficient resources within the review team to search databases, screen citations, or translate reports in other languages.

Examples of excluded items:

Exclusion criterion no.6:

- Reiss M. (2004) Students' attitudes towards science: a long-term perspective http://www.ioe.ac.uk/schools/mst/staff/ReissM/CJSMTEpub.pdf

- Jenkins E. (2006) Student opinion in England about science and technology http://www.ils.uio.no/english/rose/network/countries/uk-england/eng-jenkins-rste2006.pdf

- Jenkins E, Nelson N. (2005) Important but not for me: students' attitudes towards secondary school science http://docserver.ingentaconnect.com/deliver/connect/routledg/02635143/v23n1/s3.pdf?expires=1221563219&id=45949447&titleid=704&accname=Institute+of+Education+Library&checksum=79D8DB6951B328C5F5B482C2758CBFEE

- Breakwell G. (1992) Gender, parental and peer influences upon science attitudes and activities http://pus.sagepub.com/cgi/content/abstract/1/2/183

Exclusion criterion no. 8:

- Barnes A, Edwards A, Killeen J, Watts T. (1999) The Real Game: Evaluation of the UK National Pilot http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/16/10/77.pdf

- Luzzo D, Pierce G. (1996) Effects of DISCOVER on the career maturity of middle school students. Career Development Quarterly 45(2):170-172.

Appendix C: Coding tool

Section A: Administrative details (answer this section for studies in the map)

A.1 Identification of report (or reports)	A.1.1 Website A.1.2 Citation A.1.3 Contact A.1.4 Handsearch A.1.5 Electronic database A.1.6 Unknown
A.2 Status Please use one keyword only	A.2.1 Published A.2.2 In press A.2.3 Unpublished A.2.4 Unknown
A.3 Linked reports	A.3.1 Not linked A.3.2 Linked A.3.3 Unknown

Section B: Study aims and rationale (answer this section for studies in the map)

B.1 What is the purpose of the study?	B.1.1 Non-intervention study B.1.2 Intervention study (what works?)
B.2 Study timing? When was the study published?	B.2.1 1988-1994 B.2.2 1995-2001 B.2.3 2002-2008
B.3 What subjects does the study specifically focus on, if any?	B.3.1 Art B.3.2 Bio-chemistry B.3.3 Biology B.3.4 Business studies

	B.3.5 Chemistry B.3.6 Dance B.3.7 Design B.3.8 Drama B.3.9 Engineering B.3.10 English B.3.11 Geography B.3.12 Geology B.3.13 History B.3.14 ICT B.3.15 Mathematics B.3.16 Modern foreign languages B.3.17 Music B.3.18 Philosophy B.3.19 Physical Education B.3.20 Physics B.3.21 Psychology B.3.22 Religious education B.3.23 Science/s B.3.24 Sociology B.3.25 Technology B.3.26 Other B.3.27 None
B.4 In which country or countries was the study carried out?	B.4.1 Australia B.4.2 Austria B.4.3 Belgium B.4.4 Canada B.4.5 Czech Republic B.4.6 Denmark

	B.4.7 Finland B.4.8 France B.4.9 Germany B.4.10 Greece B.4.11 Hungary B.4.12 Iceland B.4.13 Ireland B.4.14 Italy B.4.15 Japan B.4.16 Korea B.4.17 Luxemburg B.4.18 Mexico B.4.19 Netherlands B.4.20 New Zealand B.4.21 Norway B.4.22 Poland B.4.23 Portugal B.4.24 Slovak Republic B.4.25 Spain B.4.26 Sweden B.4.27 Switzerland B.4.28 Turkey B.4.29 UK B.4.30 USA B.4.31 Other B.4.32 Marker: please select if this study compared more than one country

Section C: Study aims and rationale (answer this section for studies in the in-depth review)

C.1 What are the broad aims of the study?	C.1.1 Explicitly stated (please specify) C.1.2 Implicit (please specify) C.1.3 Not stated/unclear (please specify)
C.2 Why was the study done at that point in time, in those contexts and with those people or institutions?	C.2.1 Explicitly stated (please specify) C.2.2 Implicit (please specify) C.2.3 Not stated/unclear (please specify)
C.3 Was the study informed by, or linked to, an existing body of empirical and/or theoretical research?	C.3.1 Explicitly stated (please specify) C.3.2 Implicit (please specify) C.3.3 Not stated/unclear (please specify)
C.4 Do authors report how the study was funded?	C.4.1 Explicitly stated (please specify) C.4.2 Implicit (please specify) C.4.3 Not stated/unclear (please specify)
C.5 What are the study research questions and/or hypotheses?	C.5.1 Explicitly stated (please specify) C.5.2 Implicit (please specify) C.5.3 Not stated/unclear (please specify)

Section D: Study participants (answer this section for studies in the map)

D.1 Who are the study participants?	D.1.1 Learners/students D.1.2 Senior management D.1.3 Teaching staff D.1.4 Non-teaching staff D.1.5 Other educational practitioners D.1.6 Parents D.1.7 Other sample focus (please specify)
D.2 What type of educational institution are the study participants involved with?	D.2.1 Post-compulsory education institution/s D.2.2 Secondary school/s D.2.3 Independent school/s

	D.2.4 Other setting (please specify) D.2.5 Coding is based on: authors’ description D.2.6 Coding is based on: reviewers’ inference
D.3 What is the sex of the students?	D.3.1 Males only D.3.2 Females only D.3.3 Mixed sex D.3.4 Not stated/unclear (please specify) D.3.5 Coding is based on: authors’ description D.3.6 Coding is based on: reviewers’ inference
D.4 Does the study focus on a particular subgroup of students?	D.4.1 Gifted/talented students D.4.2 Disabled students (please specify) D.4.3 BME students (please specify) D.4.4 Other D.4.5 No
D.5 What stage of education does the students’ decision-making relate to?	D.5.1 KS3 or equivalent D.5.2 KS4 or equivalent D.5.3 KS5 or equivalent D.5.4 Not stated/unclear (please specify) D.5.5 Coding is based on: authors' description D.5.6 Coding is based on: reviewers' inference
D.6 What do the students' subject choices consist of?	D.6.1 Planned or intended choices/selections D.6.2 Actual choices/selections D.6.3 Not applicable (intervention with secondary outcomes only)

Section E: Study participants (answer this section for studies in the in-depth review)

E.1 What was the total number of participants in the study (the actual sample)?	E.1.1 Explicitly stated (please specify)

	E.1.2 Implicit (please specify) E.1.3 Not stated/unclear (please specify)
E.2 What is the proportion of those selected for the study who actually participated in the study?	E.2.1 Explicitly stated (please specify) E.2.2 Implicit (please specify) E.2.3 Not stated/unclear (please specify)
E.3 What is the socio-economic status of the individuals within the actual sample?	E.3.1 Explicitly stated (please specify) E.3.2 Implicit (please specify) E.3.3 Not stated/unclear (please specify)
E.4 What is the ethnicity of the individuals within the actual sample?	E.4.1 Explicitly stated (please specify) E.4.2 Implicit (please specify) E.4.3 Not stated/unclear (please specify)
E.5 Please specify any other useful information about the study participants.	E.5.1 Details

Section F: Exploration/description of factors (if relevant, answer this section for studies in the map)

F.1 What personal/individual factors are explored or described?	F.1.1 Age F.1.2 Gender F.1.3 Ethnicity F.1.4 Cultural influences (e.g. language spoken by ancestors) F.1.5 Health/disability F.1.6 Location (rural vs urban) F.1.7 Family SES (e.g. parental occupation; availability of money for supporting post-16 studies) F.1.8 Ability/educational attainment (e.g. prior achievements, grade levels, predicted grades) F.1.9 Pupils’ views about future educational/career-related goals and perceived future value/usefulness of subject Focus here is on the extrinsic value of the subject to the student

	subject to the student Use if (1) the focus is on the 'career usefulness' etc of the subject, or (2) the student needs to pass this subject to be accepted on their HE course of choice, or (3) the student had to take another subject in order to get into university F.1.10 Pupils' views about non-STEM subject/s e.g. enjoyment, the nature (e.g. conceptual/exploratory) of the subject F.1.11 Pupils' views about STEM subject/s F.1.12 Pupils' views about subjects appropriateness (e.g. by gender, by ability) F.1.13 Self-concept (pupils' views about own ability, e.g. perceived talent, lack of confidence) F.1.14 Pupils' views about image or 'legitimacy' (i.e. hierarchy) of subjects F.1.15 Student does not have the necessary course pre-requisites F.1.16 Pupils' prior experiences of learning a particular subject (other than achievement) F.1.17 Knowledge about provision (in student's school and/or in different institutions; e.g. their awareness or lack of awareness of other options) F.1.18 Prior knowledge of the subject e.g. student has never taken the subject before F.1.19 GPA (grade point average) concerns F.1.20 Pupils' preferred learning styles/ways of learning e.g. problem-based learning F.1.21 Cognitive preferences F.1.22 Career exploration/decision-making skills F.1.23 Other F.1.24 None

F.2 What contextual/structural factors are explored or described?	F.2.1 National/regional/local authority level factors (e.g. re curriculum or assessment reform) F.2.2 School-level factors (type of school, subjects offered, timetabling, ability-grouping of pupils, etc) F.2.3 Provision of careers-related education/advice/guidance F.2.4 Provision/structure of teaching (pedagogies/strategies) F.2.5 Teachers/other school staff influences F.2.6 Family influences (attitudes, beliefs, support, advice, guidance, encouragement, etc) F.2.7 Peer influences F.2.8 SES (e.g. of the school or neighbourhood) F.2.9 Labour market F.2.10 Media F.2.11 Other F.2.12 None

Section G: Intervention description (if relevant, answer this section for studies in the map)

G.1 If an intervention is being studied, does it have a formal name?	G.1.1 Yes G.1.2 No G.1.3 Unclear G.1.4 Marker: please select if >1 intervention is evaluated in the study
G.2 Aim/s of the intervention/s	G.2.1 Details
G.3 Type of intervention (only select >1 if >1 intervention)	G.3.1 Curriculum reform G.3.2 Teaching pedagogy/strategies G.3.3 Career education/guidance (embedded in curriculum) G.3.4 Career education/guidance (not embedded in curriculum)

	G.3.5 Career education using role modelling (e.g. visits to schools and/or visits to industrial/research sites) G.3.6 Extra-curricular activities/opportunities G.3.7 Marketing strategies G.3.8 Multi-component G.3.9 Other (please specify)
G.4 Who was involved in providing the intervention/s? (tick as many as apply)	G.4.1 Not applicable (e.g. national or school-level intervention, such as curriculum reform) G.4.2 Counsellor G.4.3 Parent G.4.4 Peer G.4.5 Researcher G.4.6 Teacher G.4.7 Occupational/educational role model G.4.8 Other (please specify) G.4.9 Not stated/unclear (please specify) G.4.10 Coding is based on: authors' description G.4.11 Coding is based on: reviewers' inference

Section H: Intervention outcomes (if relevant, answer this section for studies in the map)

H.1 What key outcomes were measured?	H.1.1 Subject choices H.1.2 Intentions re subject choices H.1.3 None
H.2 What other outcomes were measured?	H.2.1 Other relevant outcome related to subject choice (please specify) H.2.2 Attitudes to subjects H.2.3 Career choices H.2.4 Career knowledge H.2.5 Achievement/effort

	H.2.6 Educational choices not related to subject choice (e.g. FE/HE choices) H.2.7 Self-esteem/confidence H.2.8 Other H.2.9 None

Section I: Study design/method (answer this section for studies in the map, adding additional information for studies in in-depth review, if relevant)

I.1 G.3 Which of the following best describes the design/method used in the study?	I.1.1 Random experiment with random allocation to groups I.1.2 Experiment with non-random allocation to groups I.1.3 One group pre-post test I.1.4 One group post-test only I.1.5 Longitudinal observational study I.1.6 Cross-sectional study I.1.7 Views study I.1.8 Secondary data analysis I.1.9 Case-control study I.1.10 Ethnography I.1.11 Systematic review I.1.12 Other review (non systematic) I.1.13 Case study I.1.14 Document study I.1.15 Action research I.1.16 Methodological study

Section J: Methods: sampling strategy (answer this section for studies in the in-depth review)

J.1 Are the authors trying to produce findings that are representative of a given population?	J.1.1 Explicitly stated (please specify)

	J.1.2 Implicit (please specify) J.1.3 Not stated/unclear (please specify)
J.2 What is the sampling frame (if any) from which the participants are chosen?	J.2.1 Not applicable (please specify) J.2.2 Explicitly stated (please specify) J.2.3 Implicit (please specify) J.2.4 Not stated/unclear (please specify)
J.3 Which method does the study use to select people, or groups of people (from the sampling frame)?	J.3.1 Not applicable (no sampling frame) J.3.2 Explicitly stated (please specify) J.3.3 Implicit (please specify) J.3.4 Not stated/unclear (please specify)
J.4 If the study involved studying samples prospectively over time, what proportion of the sample dropped out over the course of the study?	J.4.1 Not applicable (not following samples prospectively over time) J.4.2 Explicitly stated (please specify) J.4.3 Implicit (please specify) J.4.4 Not stated/unclear (please specify)
J.5 If the study involved following samples prospectively over time, do authors provide any information on whether, and/or how, those who dropped out of the study differ from those who remained in the study?	J.5.1 Not applicable (not following samples prospectively over time) J.5.2 Not applicable (no drop out) J.5.3 Yes (please specify) J.5.4 No J.5.5 Not stated/unclear (please specify)
J.6 If the study involved following samples prospectively over time, do authors provide baseline values of key variables, such as those being used as outcomes, and relevant socio-demographic variables?	J.6.1 Not applicable (e.g. study of policies, documents etc.) J.6.2 Not applicable (not following samples prospectively over time) J.6.3 Yes (please specify) J.6.4 No J.6.5 Not stated/unclear (please specify)

Section K: Methods: recruitment and consent (answer this section for studies in the in-depth review)

K.1 Which methods were used to recruit people into the study?	K.1.1 Not applicable (please specify) K.1.2 Explicitly stated (please specify) K.1.3 Implicit (please specify) K.1.4 Not stated/unclear (please specify) K.1.5 Please specify any other details relevant to recruitment and consent.
K.2 Were any incentives provided to recruit people into the study?	K.2.1 Not applicable (please specify) K.2.2 Explicitly stated (please specify) K.2.3 Implicit (please specify) K.2.4 Not stated/unclear (please specify)
K.3 Was consent sought?	K.3.1 Not applicable (please specify) K.3.2 Participant consent sought K.3.3 Parental consent sought K.3.4 Other consent sought K.3.5 Consent not sought K.3.6 Not stated/unclear (please specify)

Section L: Methods: data collection (answer this section for studies in the in-depth review)

L.1 Which methods were used to collect the data?	L.1.1 Curriculum-based assessment L.1.2 Focus group interview L.1.3 One-to-one interview (face-to-face, telephone) L.1.4 Observation L.1.5 Self-completion questionnaire L.1.6 Self-completion report or diary L.1.7 Examination L.1.8 Clinical test

	L.1.9 Practical test L.1.10 Psychological test (e.g. IQ test) L.1.11 Hypothetical scenario, including vignettes L.1.12 School/college records (e.g. attendance, examination results) L.1.13 Secondary data, such as publicly available statistics L.1.14 Other (please specify) L.1.15 Not stated/unclear (please specify) L.1.16 Please specify any other important features of data collection L.1.17 Coding is based on: authors' description L.1.18 Coding is based on: reviewers' inference
L.2 Details of data collection instruments or tool(s)	L.2.1 Explicitly stated (please specify) L.2.2 Implicit (please specify) L.2.3 Not stated/unclear (please specify)
L.3 Who collected the data?	L.3.1 Researcher L.3.2 Head teacher/senior management L.3.3 Teaching or other staff L.3.4 Parents L.3.5 Pupils/students L.3.6 Governors L.3.7 LEA/Government officials L.3.8 Other educational practitioners L.3.9 Other (please specify) L.3.10 Not stated/unclear (please specify) L.3.11 Coding is based on: authors' description L.3.12 Coding is based on: reviewers' inference
L.4 Do the authors describe any ways that the repeatability or reliability of data collection tools/methods has been addressed?	L.4.1 Details

L.5 Do the authors describe any ways that the validity or trustworthiness of data collection tools/methods has been addressed?	L.5.1 Details

Section M: Methods: data analysis (answer this section for studies in the in-depth review)

M.1 What rationale do the authors give for the methods of analysis for the study?	M.1.1 Details
M.2 Which methods were used to analyse the data?	M.2.1 Details
M.3 Did the study use more than one method of data analysis to address the research question relevant to our review?	M.3.1 Yes (please specify) M.3.2 No
M.4 Do the authors describe strategies used in the analysis to overcome sources of bias and confounding?	M.4.1 Yes (please specify) M.4.2 No
M.5 Do the authors describe any ways that the repeatability or reliability of data analysis has been addressed?	M.5.1 Details
M.6 Do the authors describe any ways that the validity or trustworthiness of data analysis has been addressed?	M.6.1 Details
M.7 If the study used qualitative methods for data analysis, how well has diversity of perspective and content been explored?	M.7.1 Details
M.8 If the study used qualitative methods for data analysis, how well has the detail, depth and complexity (i.e. the richness) of the data been conveyed?	M.8.1 Details
M.9 If the study used qualitative methods for data analysis, has analysis been conducted such that context is preserved?	M.9.1 Details

Section N: Results and conclusions (answer this section for studies in the in-depth review)

N.1 How are the results of the study presented?	N.1.1 Details
N.2 What are the results of the study, as reported by the author(s)?	N.2.1 Details N.2.2 Further details
N.3 What do the author(s) conclude about the findings of the study?	N.3.1 Details

Section O: Quality of the study: reporting (answer this section for studies in the in-depth review)

O.1 Is the context of the study adequately described?	O.1.1 Yes (please specify) O.1.2 No (please specify)
O.2 Are the aims of the study clearly reported?	O.2.1 Yes (please specify) O.2.2 No (please specify)
O.3 Is there an adequate description of the sample used in the study and how the sample was identified and recruited?	O.3.1 Yes (please specify) O.3.2 No (please specify)
O.4 Is there an adequate description of the methods used to collect data?	O.4.1 Yes (please specify) O.4.2 No (please specify)
O.5 Is there an adequate description of the methods of data analysis?	O.5.1 Yes (please specify) O.5.2 No (please specify)
O.6 Is the study replicable from this report?	O.6.1 Yes O.6.2 No (please specify)
O.7 Do the authors state where the full, original data are stored?	O.7.1 Yes (please specify) O.7.2 No
O.8 Do the authors avoid selective reporting bias? (e.g. do they report on all variables they aimed to study, as specified in their aims/research questions?)	O.8.1 Yes O.8.2 No (please specify)

Section P: Quality of the study: Weight of Evidence (answer this section for studies in the in-depth review)

P.1 Are there ethical concerns about the way the study was done?	P.1.1 Yes (please specify) P.1.2 No P.1.3 Not stated/unclear (please specify)
P.2 Were users/relatives of users appropriately involved in the design or conduct of the study?	P.2.1 Yes, a lot (please specify) P.2.2 Yes, a little (please specify) P.2.3 No
P.3 Have sufficient attempts been made to establish the repeatability/reliability of data collection methods or tools?	P.3.1 Yes, good (please specify) P.3.2 Yes, some attempt (please specify) P.3.3 No, none
P.4 Have sufficient attempts been made to establish the validity/trustworthiness of data collection tools and methods?	P.4.1 Yes, good (please specify) P.4.2 Yes, some attempt (please specify) P.4.3 No, none
P.5 Have sufficient attempts been made to establish the repeatability/reliability of data analysis?	P.5.1 Yes, good (please specify) P.5.2 Yes, some attempt (please specify) P.5.3 No, none
P.6 Have sufficient attempts been made to establish the validity/trustworthiness of data analysis?	P.6.1 Yes, good (please specify) P.6.2 Yes, some attempt (please specify) P.6.3 No, none
P.7 To what extent are the research design and methods employed able to rule out any other sources of error/bias which would lead to alternative explanations for the findings of the study?	P.7.1 A lot (please specify) P.7.2 A little (please specify) P.7.3 Not at all (please specify)
P.8 How generalisable are the study results?	P.8.1 Details
P.9 In light of the above, do the reviewers differ from the authors over the findings or conclusions of the study?	P.9.1 Not applicable (no difference in conclusion) P.9.2 Yes (please specify)
P.10 Have sufficient attempts been made to justify the conclusions drawn from the findings, so that the conclusions are trustworthy?	P.10.1 Not applicable (results and conclusions inseparable)

	P.10.2 High trustworthiness P.10.3 Medium trustworthiness P.10.4 Low trustworthiness
P.11 Weight of evidence A: Taking account of all quality assessment issues, can the study findings be trusted in answering the study question(s)?	P.11.1 High trustworthiness P.11.2 Medium trustworthiness P.11.3 Low trustworthiness
P.12 Weight of evidence B: Appropriateness of research design and analysis for addressing the question, or sub-questions, of this specific systematic review.	P.12.1 High P.12.2 Medium P.12.3 Low
P.13 Weight of evidence C: Relevance of particular focus of the study (including conceptual focus, context, sample and measures) for addressing the question, or sub-questions, of this specific systematic review	P.13.1 High P.13.2 Medium P.13.3 Low
P.14 Weight of evidence D: Overall weight of evidence Taking into account quality of execution, appropriateness of design and relevance of focus, what is the overall weight of evidence this study provides to answer the question of this specific systematic review? *To calculate WoE D, an average of A, B and C is taken (with D not greater than A).*	P.14.1 High P.14.2 Medium P.14.3 Low

Appendix D: Overview and selected findings from the studies in the in-depth review

Table D.1: Overview of the studies included for in-depth review

Studies	Overall Weight of Evidence					Stage of education		Subjects		Countries
	H	M/H	M	L/M	L	KS4	Post-16	STEM	Non-STEM	
Bewick & Southern (1997)					✓		✓	mathematics		England
Brown et al. (2008)*			✓✓				✓	mathematics		England, Wales
Cheng et al. (1995)		✓					✓	mathematics, life sciences, physical sciences		England
Cleaves (2005)			✓				✓	science		England
Croxford (1994)		✓				✓		scientific studies, technological activities	✓	Scotland
Curry et al. (1994)					✓		✓	science	✓	N. Ireland
Darling & Glendinning (1996)					✓	✓		science, biology, chemistry, physics, technology	✓	Scotland
Gallagher et al. (1996)*			✓	✓			✓	mathematics, science	✓	N. Ireland
Gillibrand et al. (1999)				✓			✓	physics		England
Havard (1996)					✓	✓		science	✓	England
Hendley et al. (1996)					✓		✓	technology		Wales
Jarman et al. (1998)				✓		✓	✓	science		N. Ireland
Johnson (1999)		✓					✓	mathematics, science, physics	✓	N. Ireland
Matthews & Pepper (2007)			✓				✓	mathematics		England
McCarthy & Moss (1990)					✓	✓	✓	technology		Wales
Mendick (2006)			✓				✓	mathematics		England
Munro & Elsom (2000)			✓				✓	science		UK
Reid & Skryabina (2002)					✓	✓	✓	physics		Scotland
Sears (1997)					✓		✓	science	✓	England
Sharp et al. (1996)*				✓	✓		✓	mathematics, biology, chemistry, physics		England, Wales
Spielhofer et al. (2002)		✓				✓		science, biology, chemistry, physics, technology	✓	England
Springate et al. (2008)			✓				✓	chemistry, physics		England
Tebbutt (1993)					✓		✓	mathematics, physics		England
Vidal Rodeiro (2007)*		✓	✓				✓	mathematics, science	✓	England
Wikeley & Stables (1999)					✓	✓		technology	✓	England

Table D.2: Factors investigated in relation to subject choices at KS4 or equivalent (14-16 years)

Variables		No. of studies	Study details
Individual-level factors	Gender	2	Croxford (1994); Spielhofer et al. (2002)
	Socio-economic status	1	Croxford (1994)
	Ability	2	Croxford (1994); Spielhofer et al. (2002)
School-level factors	School size	1	Spielhofer et al. (2002)
	School type (single-sex/co-educational)	1	Spielhofer et al. (2002)
	School type (independent/ educational authority)	1	Croxford (1994)
	School type (religious denomination)	1	Croxford (1994)
	School type (grammar/ comprehensive)	1	Spielhofer et al. (2002)
	School type (with sixth-form/without sixth-form)	1	Spielhofer et al. (2002)

Table D.3: Factors investigated in relation to subject choices post-16

Variables		No. of studies	Study details
Individual-level factors	Gender	1	Vidal Rodeiro (2007)
	Socio-economic status	4	Cheng et al. (1995); Gallagher et al. (1996); Sharp et al. (1996); Vidal Rodeiro (2007)
	Ethnicity	2	Cheng et al. (1995); Vidal Rodeiro (2007)
	Ability (e.g. measures of prior attainment such as GCSE grades)	3	Brown et al. (2008); Cheng et al. (1995); Vidal Rodeiro (2007)
	Type of science course taken at GCSE	2	Cheng et al. (1995); Sharp et al. (1996)
School-level factors	Geographical region	1	Sharp et al. (1996)
	Location (i.e. urbanicity)	1	Vidal Rodeiro (2007)
	College size	1	Sharp et al. (1996)
	School status (degree of autonomy of school management)	1	Cheng et al. (1995)
	School type (single-sex/co-educational)	3	Cheng et al. (1995); Gallagher et al. (1996); Sharp et al. (1996)
	School type (religious denomination)	2	Gallagher et al. (1996); Sharp et al. (1996)
	School type (comprehensive/ grammar/sixth-form/etc)	2	Sharp et al. (1996); Vidal Rodeiro (2007)
	School/college academic attainment	1	Sharp et al. (1996)
	Qualifications of teaching staff	2	Cheng et al. (1995); Sharp et al. (1996)

	Gender ratio of teaching staff	2	Cheng et al. (1995); Sharp et al. (1996)
	Setting by ability	1	Sharp et al. (1996)
	Teaching time allocated to subjects pre-16	1	Sharp et al. (1996)
	Advice (various sources, both school and family)	1	Vidal Rodeiro (2007)
	Other	1	Sharp et al. (1996)

Table D.4: Reasons given by students for selection/non-selection of subjects taken at 14-16 years (Key Stage 4 or equivalent)

	Subjects	Parent/ family	School staff	Self	Enjoyment	Useful	Ability in subject	Want to do cooking/ textiles	Interest	To help father	Told not to by teacher	Don't like making	Too dependent on teacher	Restricted subject choice	Not interested in others on offer	Refer
Darling and Glendinning (1996)	Biology	*	*	**												
	Chemistry	*	*	**												
	Science	*	*	**												
	Physics	*	*	**												
	Technology (Craft and Design)	*	*	**												
Hendley et al. (1996)	Technology				**	*	*	*	*	*	*	*	*	*		
McCarthy and Moss (1990)	Technology					**			*						*	
Reid and Skryabina (2002)	Physics				*	**										
Jarman et al. (1998)	Science				**	*	*		*							
Jarman et al. (1998)	Biology, chemistry, physics (i.e. separate GCSEs)															
Darling and Glendinning (1996)	Office and information studies	*	*	**												
	Home economics	*	*	**												
	Music	*	*	**												
	French	*	*	**												
	Modern studies	*	*	**												
	History	*	*	**												
	Art	*	*	**												
	Social and vocational studies	*	*	**												
	Geography	*	*	**												
	Computing	*	*	**												
	Physical education	*	*	**												

* Reason cited by at least one young person in the study sample; not viewed as a major influence. ** Main/important reason (e.g. those most frequently cited).

Table D.5: Gender differences in young people's reasons for Key Stage 4 (or equivalent) subject selection/non-selection

	Subjects	Parent/family		School staff		Self		Useful		What doing in the subject if opted for it		Ability in subject		Content/nature/ process	
		Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Darling and Glendinning (1996)	Biology	✓			✓		✓								
	Chemistry		✓		✓	✓	✓								
	Science		✓	✓			✓								
	Physics		✓		✓	✓									
	Technology		✓		✓	✓									
Hendley et al. (1996)	Technology							✓			✓	✓			
Wikeley and Stables (1999)	'Double award' science							✓*							
Wikeley and Stables (1999)	Technology							✓*							✓*
Darling and Glendinning (1996)	Office/information studies	✓			✓		✓								
	Home economics	✓			✓		✓								
	Music	✓			✓		✓								
	French		✓		✓	✓	✓								
	Modern studies		✓		✓	✓									
	History		✓		✓	✓	✓								
	Art		✓		✓	✓									
	Social/vocational studies		✓	✓			✓								
	Geography		✓		✓	✓	✓								
	Computing		✓		✓	✓	✓								
	Physical education		✓	✓		✓									
Wikeley and Stables (1999)	Modern languages								✓*						✓*

* $p<0.05$

Table D.6: Reasons given by students for taking subjects post-16

		Teachers/school staff	Easiness/difficulty	Interested in subject	Not interested in other subjects	Enjoyment	Useful	Perceived ability	To prove something	Opportunity to participate in learning	Teaching methods	Other (not reported)	Parents/family	Peers	Mathematics content	Suitability for both genders	Do not care/chosen to complete numbers	Advice (not stated who from)	Complements other subjects	Timetable issues	Careers staff	Images of scientists	Role models
Bewick & Southern (1997)	Mathematics	*		**			**	**				*											
Cleaves (2005)	Science	*						*					*									*	
Harvard (1996)	Science	*	*	**		**	*			*	*		*		*	*							
Gallagher et al. (1996)	Science/ mathematics	*		**			**	**						*							*		
Jarman et al. (1998)	Science			**		**	**	**															
Johnson (1999)	Science																		**				
Matthew & Pepper (2007)	Mathematics			*		**	**	**										*	*				
McCarthy & Moss (1990)	Technology (CDT)			**			**																
Mendick (2006)	Mathematics					**	**		**														
Munro & Elsom (2000)	Science			**			**																
Reid & Skryabina (2002)	Physics			*		**	*	**															
Springate et al. (2008)	Chemistry	*	*			**	**				*		*	*							*	*	*
Springate et al. (2008)	Physics	*	*			**	**				*		*	*							*	*	*
Tebbutt (1993)	Mathematics			**				**															

Tebbutt (1993)	Physics			**				**															
Vidal Rodeiro (2007)	Science/ mathematics	*	*	*		*	**	**						*			*	*		*			
Vidal Rodeiro (2007)	Modern foreign languages	*	*	**		**	*	*						*			*	*		*			
Vidal Rodeiro (2007)	Arts	*	*	**		**	*	*						*			*	*		*			
Vidal Rodeiro (2007)	English	*	*	**		**	*	*						*			*	*		*			
Vidal Rodeiro (2007)	Social science/ humanities	*	*	**		**	*	*						*			*	*		*			

* Reason cited by at least one young person in the study sample; not viewed as a major influence.
** Main/important reason (e.g. those most frequently cited by young people, or ranked highly).

Table D.7: Reasons given by students for not taking subjects post-16

		Difficulty	Uninteresting/dull/boring	Perceived lack of ability and/or lack of confidence in ability	Subjects/courses taken at GCSE (lack of preparation)	GCSE classroom experience	Failure to achieve required GCSE grade	Feelings about another subject (its importance, relevance, nature etc)	GPA concerns (inc. better grades in another subject)	Timetabling restrictions/not available as option	Not useful (career/pay prospects etc)	Nature o the subject (e.g. does not allow creativity, coursework component)	Teachers/school (advice, pressure, views about, etc)	Peers	Academic attainment of school (e.g. the previous years' A-level results)	Lack of financial incentives	Does not complement/integrate with other subjects taken	Parents/family	Suitability to both genders	Maths content	Participation in learning	Teaching methods
Brown et al. (2008)	Mathematics	**	**					*			**											
Havard (1996)	Science	**	**								*		*					*	*	*	*	*
Jarman et al. (1998)	Science	**	*	*	*				*			*	*									
Johnson (1999)	Physics	**	*	*	*		*	*	*		*						*					
Johnson (1999)	Science				**																	
Matthews & Pepper (2007)	Mathematics	**	*	**	*				*		*		*	*	*	*						
Munro & Elsom (2002)	Science					**																
Johnson (1999)	English literature	*	*	*				*	*	**							*					
Johnson (1999)	Computing	*	*	*	**			*		*	*		*									
Johnson (1999)	Psychology									**		*										
Johnson (1999)	History									**							**					
Johnson (1999)	French																**					

* Reason cited by at least one young person in the study sample; not viewed as a major influence.
** Main/important reason (e.g. those most frequently cited by young people, or ranked highly).

Table D.8: Gender differences in young people's reasons for taking subjects post-16

Reasons	Studies	Subjects	Who perceived the reason to be more influential?	
Easiness of the subject	Gallagher et al. (1996)	Science/maths	boys	
	Johnson (1999)	Physics	boys	
	Johnson (1999)	Mathematics	boys	
	Johnson (1999)	Computing	x	
	Johnson (1999)	English	x	
Perceived ability	Bewick & Southern (1997)	Mathematics	boys	
	Gallagher et al. (1996)	Science/maths		girls
	Matthew & Pepper (2007)	Sciences		girls
	Jarman et al. (1998)	Sciences	boys	
	Johnson (1999)	Physics	boys	
	Johnson (1999)	Mathematics	x	
	Johnson (1999)	Computing	x	
	Johnson (1999)	English	x	
Useful for future career/education	Gallagher et al. (1996)	Science/maths		girls*
	Gallagher et al. (1996)	Science/maths	boys**	
	Matthew & Pepper (2007)	Mathematics	boys	
	Mendick (2006)	Mathematics		girls
	Johnson (1999)	Physics	x	
	Johnson (1999)	Mathematics	boys	
	Johnson (1999)	Computing	x	
	Johnson (1999)	English	x	
Interest/enjoyment	Bewick & Southern (1997)	Mathematics		girls
	Gallagher et al. (1996)	Science/maths		girls
	Matthew & Pepper (2007)	Mathematics		girls
	Mendick (2006)	Mathematics		girls
	Johnson (1999)	Physics	x	
	Johnson (1999)	Mathematics		girls
	Johnson (1999)	Computing	x	
	Johnson (1999)	English	x	
Teachers/school staff	Gallagher et al. (1996)	Science/maths		girls
	Johnson (1999)	Physics	x	
	Johnson (1999)	Mathematics	x	
	Johnson (1999)	Computing	x	
	Johnson (1999)	English	x	
Challenging	Johnson (1999)	Physics	x	
	Johnson (1999)	Mathematics	x	
	Johnson (1999)	Computing	x	
	Johnson (1999)	English	x	
Relevant to the real world	Johnson (1999)	Physics	x	
	Johnson (1999)	Mathematics	x	
	Johnson (1999)	Computing	x	
	Johnson (1999)	English	x	
Family	Gallagher et al. (1996)	Science/maths		girls
Peers	Gallagher et al. (1996)	Science/maths		girls
To prove something to others	Mendick (2006)	Mathematics	boys	
To prove something to themselves	Mendick (2006)	Mathematics		girls

x Relationship was investigated, but the author only reported results that were statistically significant.
* Usefulness of subjects for 'higher education' and for 'future careers'.
** Boys rated the reason 'well paid job' as more important than did girls.

Table D.9: School-type differences in young people's reasons for taking subjects post-16

Reasons	**Studies**	**Subjects**	**Who perceived the reason to be more influential?**	
Easiness of the subject	Johnson (1999)	Physics	x	
	Johnson (1999)	Mathematics	x	
	Johnson (1999)	Computing	x	
	Johnson (1999)	English	x	
Perceived ability	Johnson (1999)	Physics	x	
	Johnson (1999)	Mathematics	x	
	Johnson (1999)	Computing	x	
	Johnson (1999)	English	x	
Useful for future career/education	Johnson (1999)	Physics	x	
	Johnson (1999)	Mathematics	x	
	Johnson (1999)	Computing	x	
	Johnson (1999)	English	x	
Interest/enjoyment	Johnson (1999)	Physics	x	
	Johnson (1999)	Mathematics	x	
	Johnson (1999)	Computing	x	
	Johnson (1999)	English	x	
Teachers/school staff	Johnson (1999)	Physics	x	
	Johnson (1999)	Mathematics		Co-ed students
	Johnson (1999)	Computing	x	
	Johnson (1999)	English	x	
	Gallagher et al. (1996)	Science/maths		Co-ed students (boys)
	Gallagher et al. (1996)	Science/maths		Co-ed students (girls)
	Gallagher et al. (1996)	Science/maths		Protestant students
Challenging	Johnson (1999)	Physics		Co-ed students
	Johnson (1999)	Mathematics	x	
	Johnson (1999)	Computing	x	
	Johnson (1999)	English	x	
Relevant to the real world	Johnson (1999)	Physics	x	
	Johnson (1999)	Mathematics		Co-ed students
	Johnson (1999)	Computing	x	
	Johnson (1999)	English	x	

x Relationship was investigated, but the author only reported results that were statistically significant.

Table D.10: Teachers' views of the factors which encourage recruitment to mathematics and science courses post-16

	Liking/enjoyment	Career/HE choices	Previous achievement	Teacher's enthusiasm	Fits with other courses	High quality of teaching	Positive subject image	Student's aptitude	Good results achieved by previous A-level students students	Good relationship between teachers and students	Parental influence
Head of mathematics (schools)	1	2	3	4	5	6	7	7	9		
Head of mathematics (colleges)	1	2	3	4	6	7	5	9	8		
Head of science (schools)	2	1	4	3		5	8		6	6	9
Head of science (colleges)	2	1	2	4		5	6		8	9	7

1 = most commonly cited, 9 = least commonly cited

Table D.11: Teachers' views of the factors which discourage recruitment to mathematics and science courses post-16

	Perceived to be hard/harder than other subjects	Student achieved poorer results in this subject than in others at GCSE	Students put off by gap in difficulty between GCSE and A-level	Student's dislike of the mathematics	Student's dislike of the science	Low quality of teaching	Negative subject image	Poor career prospects
Head of mathematics (schools)	1	2	3	4		5	6	
Head of mathematics (colleges)	1	2	4	6		3	4	
Head of science (schools)	1	4		7	6	5	2	3
Head of science (colleges)	1	7		3	5	2	4	5

1 = most commonly cited, 7 = least commonly cited

Appendix E: Data extractions of the study findings relevant to the in-depth review

Studies	Results

Bewick & Southern (1997)

Table 1: Main reason for choosing A-level Mathematics (p.75)

Response	1	2	3	4	5	Total
Boys	39 (28.7)	6 (8.6)	45(44.6)	21 (27.5)	10 (11.6)	121
Girls	8(18.3)	8 (5.4)	28 (28.4)	24 (17.5)	9 (7.4)	77
Total	47	14	73	45	19	198

Figures in brackets are expected frequencies assuming no gender effect.

1 = Good grades at GCSE
2 = Influenced by teacher or other adult
3 = Relevant to your intended career
4 = Particular interest
5 = Other

“Although the relationship between gender and A-level choices was not the main focus… It was decided to see whether there is a significant difference between boys and girls in why they choose to study mathematics beyond GCSE. There is a highly significant difference (x2=15.94, p=0.003) between boys and girls in why they choose mathematics. It appears that boys are more influenced by good GCSE grades than are girls, whereas girls are more likely than boys to choose the subject because they are interested in it. … The sample sizes for those choosing A-Level Further Mathematics were too small to carry out a hypothesis test, but 19 of 24 boys chose the subject our of interest or because it was relevant to their intended careers, whereas 3 of the 5 girls chose it because they were interested in the subject and the remaining 2 because they did well at GCSE.” (pp.74-5)

“Conversely, it was possible that more students wanted to study mathematics than started the courses. To determine this they were asked whether there were any subjects they would have liked to study at A-level but were unable to do so and to give reasons. Three students were unable to study mathematics because their GCSE grades were not good enough; one decided it would be too difficult; and four were prevented by timetable crashes. Two students could not take A-level Statistics because of timetable clashes, and two said that they would have taken A-level Statistics had the course been offers.” (p.76)

Brown et al. (2008)

Table 2: Student reasons for not continuing with mathematics, by predicted grade (p.6)

Predicted grade	A* (n=23)	A (n=96)	B (n=317)	C (n=540)
too difficult	22%	47%	62%	58%
do not enjoy/like it	17%	39%	39%	30%
boring	13%	20%	13%	14%
not needed for future degree/career	35%	13%	10%	10%
not useful in life	9%	6%	3%	2%
prefer other courses	17%	3%	2%	3%

Table 4: Student reasons for not continuing with mathematics, by gender (p.12)

Gender	Male (n=598)	Female (n=673)
too difficult	37	66

do not enjoy/like it	24	35
boring	12	15
not needed for future degree/career	7	10
not useful in life	3	3
prefer other courses	2	3
not continuing with education	7	3

Authors argue that their data makes it clear that "lack of confidence" is a common reason for not continuing with mathematics among high attaining girls and provide quotes in support of this.

Authors state that "comparing students that were predicted the same grade across schools, there was a relatively wide variation in the proportion of students intending to continue with mathematics, suggesting that the school attended had a significant impact" (p.12).

Table 5: Correlations between school attitude and participation within mathematics (p.14)

School index for student attitude towards mathematics					
	Like	Enjoy	Anxious	Easy	Predicted attainment in mathematics
Correlations with student intended participation	0.59	0.65	-0.04	0.10	-0.07

Authors went on to investigate the two schools with the lowest and the three with the highest 'participation indices'. They state that "from the attitude word survey, it was clear that the students in all three [highest participating] schools were consistent in finding mathematics significantly more enjoyable (and less boring) than the average. This lends further support to the high correlation across all schools found between enjoyment and participation at the school level...In the two schools with the lowest participation indices, students were particularly negative about the difficulty and boring nature of mathematics, even after the correction for distribution of attainment had been made." (p.14). Authors state that "there was no support for the hypothesis that students predicted grade B were more likely to be discouraged from continuing in mathematics in schools with a significant 'clever core' of students predicted to get A* and A grades; in fact the opposite seemed to be the case" (p.15) Authors note that in 3 cases out of 5, comments by Ofsted inspectors on the schools in the study "seemed to support our findings about enjoyment" (p.15). Authors note that there were considerable differences between the schools in their participation indices and "what differentiated schools very clearly was the mean level of student scores on the enjoyment scale (which included the selection of the words 'excited', 'enjoy' and 'bored')." (p.15)

Cheng et al. (1995)

Table 3.1: Models for the probability of choosing physical sciences at GCE A-level: students in full-time education in year 12 studying for at least two GCE A-levels (pp.17-8)

	Model 3 (with school level predictors)	
	Estimate	s.e.
constant	****1.49	0.39
Individual level predictor variables		
Sex and type of school		
Girls from girls' schools	-	-
Boys from boys' schools	1.10****	0.30
Girls from mixed schools	0.51**	0.24
Boys from mixed schools	1.42****	0.24

No information	1.54**	0.76
Ethnicity		
White	-	-
Black	0.68	0.74
Asian	0.96****	0.24
No information	1.23**	0.48
Parental occupation		
Professional/intermed	-	-
Junior non-man/skilled	0.06	0.12
Low skilled	0.37	0.22
No information	0.29	0.24
Parental education		
Degree	-	-
A level	-0.12	0.17
Neither of these	-0.05	0.14
No information	0.03	0.22
Parental employment		
Neither in full-time job	-	-
1 or both in full-time job	0.10	0.22
GCSE physical science subjects		
Physics and chemistry	-	-
Physics	-0.83****	0.18
Chemistry	-0.94***	0.22
Combined/balanced science	-1.08****	0.17
Other combinations	-0.15	0.24
None+	14.05	792.80
GCSE physical science mean grade		
A	-	-
Between A and B	-0.37	0.21
B	-0.84****	0.15
Between B and C	-0.84****	0.23
C	-1.57****	0.18
Below C	-2.94****	0.27
Did not sit GCSE+	-17.64	792.90
GCSE mathematics grade		
A	-	-
B	-0.66****	0.13
C	-2.10****	0.17
D or lower	-3.79****	0.49
Did not sit GCSE	-0.39	0.67
GCSE biology grade		
A	-	-
B	0.32	0.21
C	0.18	0.25
D or lower	0.40	0.46
Did not sit GCSE	0.68****	0.18
Other GCSEs		

Number of A-C grades	-0.31****	0.04
School level predictor variables		
Status		
Voluntary aided	-	-
LEA maintained	-0.15	0.18
Voluntary controlled	-0.38	0.25
Special agreement	-0.34	0.50
School level variation	*0.21****	*0.08*

+ The categories for these two parameters have very large standard errors and should be ignored.
Significance levels: *10%, ** 5%, *** 1%, **** 0.1%

Table 3.3: Multi-level model for the probability of mathematics at GCE A-level: students in full-time education in year 12 studying for at least two GCE A-levels (p.23)

	Model 3 (with school level predictors)	
	Estimate	s.e.
constant	****1.49	0.39
Individual level predictor variables		
Sex and type of school		
Girls from girls' schools	-	-
Boys from boys' schools	0.89***	0.28
Girls from mixed schools	0.50**	0.22
Boys from mixed schools	1.12****	0.22
No information	0.18	0.79
Ethnicity		
White	-	-
Black	1.03	0.59
Asian	0.87****	0.24
No information	0.56	0.47
Parental occupation		
Professional/intermed	-	-
Junior non-man/skilled	0.03	0.11
Low skilled	0.4**	0.19
No information	0.15	0.22
Parental education		
Degree	-	-
A level	-0.04	0.16
Neither of these	0.27**	0.13
No information	0.36	0.21
Parental employment		
Neither in full-time job	-	-
1 or both in full-time job	-0.25	0.20

GCSE physical science subjects		
Physics and chemistry	-	-
Physics	-0.29*	0.16
Chemistry	-0.65****	0.18
Combined/balanced science	-0.64****	0.16
Other combinations	-0.08	0.23
None+	16.44	601.70
GCSE physical science mean grade		
A	-	-
Between A and B	-0.29	0.23
B	-0.36**	0.15
Between B and C	-0.24	0.23
C	-0.48***	0.17
Below C	-1.10****	0.21
Did not sit GCSE+	-17.95	601.70
GCSE mathematics grade		
A	-	-
B	-1.27****	0.13
C	-3.47****	0.16
D or lower	-5.71****	0.40
Did not sit GCSE	-2.70****	0.60
GCSE biology grade		
A	-	-
B	0.30	0.20
C	0.28	0.22
D or lower	0.23	0.34
Did not sit GCSE	0.84****	0.18
Other GCSEs		
Number of A-C grades	-0.27****	0.04
School level predictor variables		
Status		
Voluntary aided	-	-
LEA maintained	-0.37**	0.17
Voluntary controlled	-0.68***	0.25
Special agreement	-0.80*	0.47
School level variation (before inclusion of school level predictors)	*0.36*****	*0.09*
School level variation (remaining after inclusion of school level predictors)	0.33****	0.08

+ The categories for these two parameters have very large standard errors and should be ignored.
Significance levels: *10%, ** 5%, *** 1%, **** 0.1%

Table 3.4: Multi-level model for the probability of choosing life sciences at GCE A-level: students in full-time education in year 12 studying for at least two GCE A-levels (p.26)

	Estimate	s.e.

constant	****1.49	0.39
Individual level predictor variables		
Sex and type of school		
Girls from girls' schools	-	-
Boys from boys' schools	-0.14	0.25
Girls from mixed schools	0.49***	0.18
Boys from mixed schools	-0.08	0.19
No information	-0.56	0.84
Ethnicity		
White	-	-
Black	-0.48	0.64
Asian	0.42**	0.21
No information	-0.51	0.48
Parental occupation		
Professional/intermed	-	-
Junior non-man/skilled	0.06	0.11
Low skilled	0.15	0.19
No information	0.07	0.20
Parental education		
Degree	-	-
A level	-0.01	0.16
Neither of these	0.08	0.12
No information	0.17	0.20
Parental employment		
Neither in full-time job	-	-
1 or both in full-time job	0.12	0.18
GCSE physical science subjects		
Physics and chemistry	-	-
Physics	-0.66****	0.20
Chemistry	-0.01	0.15
Combined/balanced science	1.25****	0.19
Other combinations	0.57**	0.23
None	0.51	0.69
GCSE physical science mean grade		
A	-	-
Between A and B	-0.35	0.24
B	-0.25	0.16
Between B and C	-0.29	0.26
C	-0.47***	0.17
Below C	-1.03****	0.20
Did not sit GCSE	-2.14****	0.69
GCSE mathematics grade		
A	-	-
B	0.39***	0.15

C	0.61****	0.16
D or lower	0.27	0.21
Did not sit GCSE	-0.21	0.81
GCSE biology grade		
A	-	-
B	-0.14	0.17
C	-0.68****	0.18
D or lower	-2.46****	0.29
Did not sit GCSE	-3.20****	0.20
Other GCSEs		
Number of A-C grades	-0.16****	0.04
School level predictor variables		
Status		
Voluntary aided	-	-
LEA maintained	0.01	0.15
Voluntary controlled	-0.10	0.22
Special agreement	0.66*	0.36
School level variation (before inclusion of school level predictors)	*0.10**	*0.06*
School level variation (remaining after inclusion of school level predictors)	0.08	0.06

Significance levels: *10%, ** 5%, *** 1%, **** 0.1%

Cleaves (2005)

1. Like Madeline, students with a ‘directed’ trajectory who included science in their post-16 courses had stable career ideas over 3 years, which lead directly to their choices. Two were intent on a career in sports science, one was resolved on medicine and one wanted to be a marine archaeological geophysicist.
2. Among the non-science choices of students with a ‘directed’ trajectory, career aims included careers in sports (taking PE rather than sports science, not generally regarded as a science), beauty therapy, art, catering, law and architecture. The reaction of year 10 students to a list of science-related careers such as food science, pollution control and speech therapy supported Hill and Wheeler’s (1991) suggestion that students have limited images of what constitutes science work. Despite showing an ignorance of the scope of science work, students often showed an interest in some of the careers presented. The occupations to which students with a ‘directed’ trajectory aspired can all be considered to be high visibility occupations.
3. Out of 16 students who a ‘partially resolved’ trajectory, six chose science — all with mathematics. Five students chose to study physical sciences, four in the form of mathematics and physics and one (James) within a course of aerospace engineering.
   Like Will their choices were traditional science and mathematics combinations, which could have led to a career in science, but other than James they had not decided upon a specific career in science by the end of year 11 and had usually selected mathematics to improve career prospects. Will, who criticized some teaching and who considered science practical work to be pedantic, still chose science despite dissatisfactions. Kester, who was keen on both art and drama, chose A-levels to make him ‘think a lot’; namely, physics, mathematics, further mathematics and computing. Mary, for similar reasons, chose physics, mathematics

	and philosophy, and described her choice as an intellectual challenge, despite her description of science at school as ‘not particularly inspirational’. Tom chose physics and mathematics with computer science and media studies for breadth. Physics and mathematics were considered to be intellectually demanding, strong and versatile subjects and not, at that stage, because the student wanted specifically to pursue a career as a mathematician or a scientist. 4. Laura was one of two people out of 16 with a ‘funnelling identifier’ trajectory who included science in their post-16 choices. She was discouraged from taking up sciences, although she chose one science A-level in a mixed A-level combination. A lack of confidence in her ability to pursue science further seems to have contributed to her decisions. Joseph, who also had a ‘funnelling identifier’ choice trajectory, retained an interest in studying a variety of subjects including English and geography. Over time he became increasingly interested in and more inclined to choose science subjects and made a positive choice for science and chose mathematics, physics and chemistry at A-level, despite finding science ‘more boring this year’ in year 11. 5. About two-thirds of the students with a ‘funnelling identifier’ trajectory eliminated science from their choices by negative selection. Among those with this trajectory who did not choose science Charlotte was typical because she found little in secondary school science to interest her, other than selected topics like evolution. She seemed unaware of the enormity of the field of evolutionary science. 6. The link between science attitudes and science uptake could most satisfactorily be applied to the students in this study with a ‘funnelling identifier’ trajectory, who made up a significant proportion of the sample (16 out of 69, 23%). There was a trend among students with this trajectory who did not choose science to achieve higher GCSE grades in subjects other than science, and this seemed to be associated with their negative attitude to science. 7. The eight students with a ‘precipitating’ trajectory who chose sciences were the antithesis of the young scientist committed from an early age depicted by Head (1997). Richard was typical in having unformed ideas about a future career throughout secondary school and then finding the choice between subjects difficult. Students like Richard used their own experiences to put together a strong, flexible and broad combination of subjects, of which science was a component. For students with a ‘precipitating’ trajectory who chose science, breadth meant a combination of science and non-science subjects, a mixed A-level choice. There is evidence that some students were given advice by careers advisors against taking mixed A-levels. 8. Parents of several people with a ‘multiple projection’ or ‘precipitating’ trajectory advised their children about the traditional ‘educational capital’ (Bourdieu and Passeron 1977) of some subjects over others, and they were therefore privileged in acquiring knowledge about subjects with high currency for deferred vocational choices. In Madeline’s portrait we see that her parents described mathematics as a ‘solid subject’. Daniel’s father advised that physics was a ‘more fundamental’ subject than music to complement the choice of electronics and music technology, Simon was encouraged to select physics over theatre studies because his father considered the latter to be a ‘fluffy subject’, and Hester’s choice of biology followed her mother’s advice to choose a ‘definite science’ subject with geology and geography. pp.479-481
Croxford (1994)	Probability of studying at least one subject in each mode. Models including ability, when all other variables are held constant at the average for the sample. Scientific studies Ability: High 0.95 (0.00), Medium 0.87, Low 0.82 Class: Non manual 0.90, manual 0.87 School: EA non-denominational 0.85 (0.00), EA Roman Catholic 0.87, Independent 0.92 (0.02) Sex: Male 0.91 (0.00), female 0.85 Technological studies

	Ability: High 0.53, Medium 0.78, Low 0.85 Class: Non manual 0.65, manual 0.76 School: EA non-denominational 0.82 (0.00), EA Roman Catholic 0.76, Independent 0.57 (0.02) Sex: Male 0.71, female 0.73 Modern languages Ability: High 0.77, Medium 0.54, Low 0.44 (0.02) Class: Non manual 0.66, manual 0.55 School: EA non-denominational 0.46 (0.00), EA Roman Catholic 0.48, Independent 0.84 (0.02) Sex: Male 0.51, female 0.67 Social and environmental Ability: High 0.94, Medium 0.94, Low 0.90 Class: Non manual 0.93 (0.00), manual 0.92 (0.00) School: EA non-denominational 0.91 (0.00), EA Roman Catholic 0.93 (0.00), Independent 0.94 Sex: Male 0.94 (0.00), female 0.91 Creative and aesthetic Ability: High 0.38, Medium 0.46, Low 0.57 (0.02) Class: Non manual 0.45, manual 0.46 School: EA non-denominational 0.46 (0.00), EA Roman Catholic 0.42, Independent 0.50 (0.02) Sex: Male 0.44, female 0.49 Note: (0.01) Standard errors for all probabilities where not shown. Modes of study in the study based on the curriculum framework from Scottish Consultative Council on the Curriculum are defined as: -Scientific studies: biology or chemistry or physics or science -Technological activities: computing studies, craft and design, home economics, office and information studies, technological studies -Modern languages: not include English -Social and environment studies: classical studies or contemporary social studies or economics or geography or history or modern studies -Creative and aesthetic activities: art and design, drama, music
Curry et al. (1994)	A-level subject choice 1) careerists were significantly (chi sq=10.3 df =3 p<0.05) more likely to be taking science only or science-dominant subject (40%) as compared to non-careerists (22%), while non-careerists were more likely to be taking arts or art-dominant subjects (61%) compared to careerists (49%). Advance level subject choice by career type for girls (from Table 3) science only/science dominant • Careerist 40.3% non careerists 22.5% Arts only /arts dominant • Careerist 48.9% non careerists 61.2% • Non dominant careerist 10.9 non careerist 16.2% Total careerist 129 non careerist 111 (significance: chi sq=10.4, df=4, p<0.05)
Darling & Glendinning (1996)	Gender differences in perceptions of self, parents, and school staff (respectively) as having had a major influence on choosing subject, for pupils studying selected Standard Grades (third and fourth year pupils in seven local authority secondary schools). (Table 6.10, p.113.)

Office and information studies

	Self	Parents	Staff
female	81%	28%	26%
male	72%	37%	17%

Home economics

	Self	Parents	Staff
female	84%	24%	16%
male	67%	48%	0%

Biology

	Self*	Parents	Staff
female	86%	20%	26%
male	76%	32%	11%

Music

	Self	Parents	Staff
female	86%	24%	26%
male	71%	36%	20%

French

	Self	Parents	Staff
female	81%	32%	27%
male	80%	31%	17%

Modern studies

	Self	Parents	Staff
female	85%	34%	28%
male	86%	31%	21%

History

	Self	Parents	Staff
female	89%	21%	26%
male	78%	19%	16%

Art

	Self	Parents	Staff
female	85%	24%	28%
male	86%	22%	18%

Social and vocational studies

	Self	Parents	Staff
female	85%	31%	33%
male	65%	17%	31%

Chemistry

	Self*	Parents	Staff
female	89%	19%	20%
male	87%	14%	14%

Science

	Self*	Parents	Staff
female	76%	31%	32%
male	64%	19%	31%

Geography

	Self	Parents	Staff
female	86%	31%	27%
male	85%	21%	19%

	Computing Self Parents Staff female 86% 22% 21% male 85% 20% 20% Physical education Self Parents Staff female 67% 30% 17% male 78% 25% 24% Physics Self Parents Staff female 87% 28% 31% male 89% 22% 14% Craft and design Self Parents Staff female 75% 47% 33% male 77% 21% 14% "In the majority of subjects boys and girls were equally likely to feel that their own views were of primary importance when deciding to study a subject. But there are some interesting gender differences within specific subjects. These are: office and information studies, home economics, biology, music, social and vocational studies, general science and physical education. In all of these subjects (with the notable exception of physical education) girls were more likely than boys to regard themselves as having had a major influence on choosing to study the subject. Physical education is the only subject in the table where boys are more likely than girls to see themselves as a major influence. Four of the subjects where girls are more likely than boys to see themselves as influential are also the four predominantly 'female' subjects in the table (i.e. office and information studies, home economics, biology and music). And these are the four subjects where boys were more likely than girls to report that their parents had a significant influence; parental influence was seen as more important by girls than boys in all other subjects, although in some instances these differences were small. The remaining three subjects where there was evidence of gender differences in the degree of influence reported by pupils themselves (i.e. social and vocational studies, general science and physical education) are also those subjects where the picture is different for staff influences. In the great majority of subjects girls are more likely than boys to see staff as influential, but in social and vocational studies, general science and physical education the relative influence of staff on boys would appear to be greater than in other subjects. Physical education is the one subject where staff influences are significantly greater on boys than girls." (pp.114-5)
Gallagher et al. (1996)	Boys attending co-educational schools are taking a significantly higher number of maths/science A levels than those attending single-sex schools (1.67 and 1.28 respectively, $p<0.001$). For girls, there is no significant difference between co-educational and single-sex schools (1.18 and 1.27 respectively, ns). Boys attending Protestant schools are taking a significantly higher number of maths/science A levels than those attending Catholic schools (1.64 and 1.24 respectively, $p<0.001$). Girls attending Protestant schools are taking a significantly higher number of maths/science A levels than those attending Catholic schools (1.38 and 0.92 respectively, $p<0.001$). (Statistical Annex, p.5) "Both sexes disagree to some extent that they were actively encouraged by staff to pursue science at A-level; however, boys seem to disagree significantly more. The same is also true for boys at single-sex schools compared to those at co-educational and for Catholics compared to Protestants. In addition, boys seem to be more strong-minded than girls in relation to whether they take advice on subjects relating to future career, the same is also apparent for boys at co-educational schools compared to those at single-sex." (Statistical

Annex, p.20)

Table 11(e) Attitude to teacher by sex, type of school and religion (Statistical Annex, p.20)

Items	Boys	Girls	Boys s-sex	Boys co-ed	Girls s-sex	Girls co-ed	Protes.	Cath.
U	3.81	3.59*	3.92	3.62*	3.63	3.56 ns	3.56	3.86*
V	3.08	2.92**	3.01	3.19***	2.92	2.93 ns	3.00	2.99 ns

U: I was actively encouraged by a member of staff to pursue science subjects at A-level
V: If a careers teacher advised me against choosing a career because I was not capable, I would accept the advice.
* p<0.0; ** p<0.01; *** p<0.05
high scores = disagreement; low scores = agreement

Table 12(b) Important influences on subject choice by type of student (Statistical Annex, p.23)

Reason	Science students	Arts students	Mixed students
Father	2.30	2.26	2.46 ns
Mother	2.19	2.12	2.23 ns
Subject teacher	2.00	1.88	1.87 [a]
Principal	2.82	2.76	2.83 [a]
Careers teacher	2.29	2.28	2.31 ns
Friend(s)	2.67	2.59	2.80 [a]
Older brother(s)	2.48	2.53	2.89 [b]
Older sister(s)	2.48	2.53	2.94 [b]

Scores ranged from 1 to 3 – the lower the score the more important the reason
[a] Significantly different between science and arts (p<0.05)
[b] Significantly different between science and mixed, arts and mixed (p<0.05)

Table 12(c) Important influences on subject choice by sex by type of student (Statistical Annex, p.23)

Reason	Science boys	Arts boys	Mixed boys	Science girls	Arts girls	Mixed girls
Father	2.30	2.29	2.60 ns	2.30	2.24	2.43 ns
Mother	2.19	2.19	2.33 ns	2.19	2.07	2.21 [b]
Subject teacher	2.19	2.05	1.43 [a]	1.79	1.76	2.00 ns
Principal	2.79	2.77	2.71 ns	2.85	2.76	2.88 [b]
Careers teacher	2.30	2.36	1.86 ns	2.27	2.23	2.47 ns
Friend(s)	2.70	2.63	2.71 ns	2.64	2.56	2.83 [b]
Older brother(s)	2.51	2.50	2.67 ns	2.45	2.56	2.94 [c]
Older sister(s)	2.57	2.62	2.67 ns	2.39	2.46	3.00 [c]

Scores ranged from 1 to 3 – the lower the score the more important the reason
[a] Significantly different between science and arts, science and mixed, arts and mixed (p<0.05)
[b] Significantly different between science and arts (p<0.05)
[c] Significantly different between science and mixed, arts and mixed (p<0.05)

Table 13(b) Reasons for taking A-level subjects by type of student (Statistical Annex, p.25)

Reason	Science students	Arts students	Mixed students
Well paid job	1.62	1.75	1.84[a]
Friends doing	2.86	2.82	2.84 ns

them			
Good at them	1.24	1.27	1.39 ns
Higher education	1.36	1.45	1.55 [a]
Future career	1.24	1.45	1.61 [b]
Easy option	2.84	2.69	2.68 [a]
Encouraged by staff	2.45	2.44	2.45 ns
Encouraged by careers staff	2.55	2.56	2.68 ns
Most interesting	1.61	1.54	1.77 [a]

Scores ranged from 1 to 3 – the lower the score the more important the reason
[a] Significantly different between science and arts (p<0.05)
[b] Significantly different between arts, science and mixed (p<0.05)

"Science students appear to have their eyes firmly fixed upon higher education, future career and that the subject choices will lead to a well paid job, whereas arts students express a greater importance on the A-level being an easy option and the most interesting." (p.24)

Table 13(c) Reasons for taking A-level subjects by sex and type of student (Statistical Annex, p.26)

Reason	Science boys	Arts boys	Mixed boys	Science girls	Arts girls	Mixed girls
Well paid job	1.51	1.62	1.29 [a]	1.74	1.84	2.00 [a]
Friends doing them	2.82	2.76	2.57 ns	2.90	2.86	2.92 ns
Good at them	1.25	1.31	1.00 ns	1.23	1.24	1.50 [b]
Higher education	1.38	1.51	1.14 [a]	1.35	1.41	1.67 [b]
Future career	1.28	1.54	1.14 [a]	1.20	1.38	1.75 [c]
Easy option	2.81	2.60	2.29 [d]	2.87	2.75	2.79 [a]
Encouraged by staff	2.52	2.54	2.57 ns	2.37	2.36	2.42 ns
Encouraged by careers staff	2.55	2.59	2.71 ns	2.55	2.54	2.67 ns
Most interesting	1.68	1.61	1.43 ns	1.53	1.49	1.88 [b]

Scores ranged from 1 to 3 – the lower the score the more important the reason
[a] Significantly different between science and arts (p<0.05)
[b] Significantly different between science and mixed, arts and mixed (p<0.05)
[c] Significantly different between science and arts, science and mixed, arts and mixed (p<0.05)
[d] Significantly different between science and arts, science and mixed (p<0.05)

Qualitative analysis (Section 4, pp.16-20):
"We next discussed the reasons for A-level choices. For (female) science students the main reason for their subject choice was a particular university course and ultimately career aspirations. They chose the subjects that were necessary for entry on to a specific degree course, with medical courses particularly mentioned…

The majority of (female) arts students, on the other hand, had no specific degree courses in mind when choosing A-level subjects. Rather, a more typical comment was that they wanted to keep their options open and so mainly chose subjects in which they had achieved good GCSE grades, as well as subjects they enjoyed and felt had a talent for."

"Teachers could be an influence on all the participants, although the influence could be positive or negative."

"The qualitative evidence from the focus group discussions suggests however that the changes in subject choice may be attributable less to the girls' perceptions of the academic subjects themselves, and more to their perceptions of the occupational opportunities that are open to them in the future."

Gillibrand et al. (1999)

The relationship between final confidence scores and choosing to do A-level physics for cohorts 1 and 2 combined was reported. None of those in the lowest confidence group proceeded to take A-level physics (x^2=16.4, df=2, p<0.0005). (p.355)

Table 4. Girls choosing A-level physics as a function of three levels of confidence (cohorts 1 and 2) (p.356)

Final confidence score*		<27	27-32	>32
	Chose A-level science (no)	12	12	5
	Chose A-level science (yes)	0	8	14

* One girl did not complete the final confidence score

Havard (1996)

Table 1: Factors influencing students' decisions about science A-levels (p.325)

Factors	Total non-science	Total science	Rank non-science	Rank science	SQ rank difference (d^2)
Interest in subject	154	75	1	1	0
Advice from teachers	290	138	7	5.5	2.25
Advice from parents	312	151	9	9	0
Career prospects	284	129	6	3	9
Participation in learning	257	126	4	2	4
Pay prospects	298	146	8	8	0
Maths content	280	144	5	7	4
Teaching methods	234	132	3	4	1
Difficulty	215	138	2	5.5	12.25
Suitability to both gender	352	192	10	10	0

"Students indicated that interest and enjoyment were very important factors influencing them in their choice of A levels. It is not surprising that these influence the uptake of science A-levels; however, a crucial finding, apparent throughout the survey, was that attitudes to the individual science vary greatly." (p.323)

Hendley et al. (1996)

Reasons for choice of Technology (Table IX, p.25)

Reason	Boys	Girls
In order to get a job	9	5
Enjoyment of making	8	9
Want to do cooking/textiles	0	7
Ability in subject	4	2
To help father	1	0

"The constraints imposed by some respondents, mainly girls, were concerning the areas of Design and Technology within which they would be willing to work. This almost invariably concerned Home Economics and Textiles." (p.25)

Reasons for not taking Technology (Table X, p.26)

Reason	Boys	Girls
Not good at it	5	1
Not interesting/don't like it	5	3
Not important/not useful for a job	2	1
Told not to by a teacher	1	0
Don't like making	0	2
Too dependent on the teacher	0	1
Restricted subject choice	0	3

"Boys' views seemed to hinge around their abilities in the subject, whereas girls were more concerned about what they would be doing in Technology if they opted for it." (p.26)

Jarman et al. (1998)

Reasons for taking subjects at KS4:
The survey shows that interest/enjoyment, ability and relevance to future careers were among the most common reasons for pupils opting for the maximum science programme. Interestingly, more respondents made career-related comments in those schools with full year career programmes than in other schools. It is noteworthy that a great number said they chose their particular science programmes because they wanted to do medicine or related work. (pp.12-3)

Over 20% explicitly and differentially linked their choice with their perceived aptitude for science. Over 20% indicated that doing additional science would have left them with few, if any, discretionary subjects. There was evidence that many young people were opting for choice rather than against science. A number, about 9% in the interview sample and 5% in the questionnaire sample, indicated that they chose triple science because it was a better preparation for A-level science. (pp.12-3)

Though the matter was discussed with classmates, there was surprisingly little evidence of pupils' choosing particular options simply because their friends were doing so. (pp.12-3)

Reason for taking/not taking subjects post-16:
*The major factor which discouraged young people, from whatever background, from pursuing science post-16 was that they perceived it to be more difficult than other subjects. It was widely believed that one could only do A level chemistry, and particularly A level physics, if one was very able.
*The second most common reason for discontinuing science post-16 was a lack of interest in the subject.
*Around one-tenth of those who dropped science indicated that they were interested in the subject but had dropped it for other reasons, including the fact that it was easier to score good grades in other subjects. In this context, too, some appealed for a broader base to A level study.
*Some young people opted out of science because they regarded it as impersonal or unfulfilling for those of a creative mind.

"...the survey showed that interest/enjoyment, ability and relevance to future careers were the most common reasons for pupils proposing to study science A levels. In respect of the former, the role of 'relevance to everyday life' in promoting interest to science was frequently mentioned and it is clear that this is an important issue with pupils. A number, but significantly more boys than girls, claimed that they wished to study science because they were good at the subject. The link between career intention, most particularly career intention in medicine or related fields, and science choice was also very strong.

For both the interview and questionnaire samples, the major factor influencing choice against

	the sciences was the perceived difficulty of these subjects at A level and the related concern that the respondent had not the ability to tackle advanced study in chemistry and, particularly, in physics. Almost 70% of those interview pupils who hoped to proceed to A level study indicated a belief that A level study in the sciences was more difficult than in other curricular areas and that it was easier to score good grades in other subjects. There is evidence from this survey that these perceptions serve to depress the uptake of science post-16. A number of pupils in both the interview and questionnaire sample who had taken double award reported either that they lacked confidence to proceed to A level study in the separate sciences or that they felt poorly prepared for such A level study, in absolute terms, or in comparison with those who had taken the triple science programme. A few indicated that they had been told they should limit their uptake of science to one subject alone. Such responses were more prevalent among pupils from some schools than others. ...some young people dropped science because they felt that it was impersonal or not well suited to the creative mind." (pp. 40-1) "There is evidence from this survey, that if the link between triple science and advanced study is stressed, it adversely affects the confidence of pupils with double science backgrounds to proceed to A level." (p.12)
Johnson (1999)	RESULTS FROM THE FIFTH-FORM STUDY *Addressing the research aim to explore GENDER differences in reasons for A-level choices:* *ANOVAs were performed for English, Maths and Physics and Computing. Author states that she reported only the significant results.* Interest: Significant effect of gender for ratings of interest for English (F(1,125)=5.72, p=0.018) and for maths (F(1,159)=8.69, p=0.004). Females gave higher mean ratings for interest than males in both subjects. Expected success: Significant effect of gender found for ratings of expected success in physics (F(1,193)=7.81, p= 0.006), with males giving a higher rating for expected success than females. Suited to personality: Significant effect of gender for ratings in English (F(1,125)=5.07, p=0.026), with females having a higher mean rating than males. Challenging: Significant effect of gender for challenge in choice of computing (F(1,47)=5.12, p=0.028), with females giving a higher rating for challenge than males. Useful for career: Significant effect of gender for career in maths (F(1,159)=5.89, p=0.016). Males gave a higher rating for career than females. Useful for higher/further education: Again for maths, a significant effect of gender was identified with males giving a higher rating for education than females (F(1,159)=4.73, p=0.031). Easier than other subjects: Significant effects for maths (F(1,159)=7.31, p=0.008), physics (F(1,193)=4.23, p=0.043) and computing (F(1,147)=8.88, p=0.005), with males having a higher rating of ease for each subject than females. For English, author reports that there was a two-way interaction between gender and school type for ease of subject (F(1,125)=8.77, p=0.004). Post hoc analysis revealed a significant effect of gender for single-sex educated students of English (t(61)=2.70, p=0.009), with single-sex educated females having a lower rating of ease of subject for English than all other students. *Addressing the research aim of exploring SCHOOL TYPE differences in preference and choices:*

	Again, ANOVAs were performed for English, Maths and Physics and Computing, and the author reported only the significant results: Recommended by school: Significant effect of school type for maths (F(1,159)=9.91, p=0.02), with co-educated students giving this reason a higher rating for choice of maths than single sex educated students. Challenging: Effect of school type for physics (F(1,93)=6.56, p=0.012), with co-educated students giving challenge a higher rating for choice of physics than single sex educated students. Recommended by parents: Significant effect of school type for English (F(1,125)=3.96, p=0.049), with co-educated students giving this a higher rating than single sex educated students. Relevant to the real world: Effect of school type for maths (F(1,159)=5.16, p=0.024). Co-educated students gave this reason a higher rating for choice of maths than single sex educated students. For English there was a two-way interaction between gender and school type for ease of subject (see above). Post hoc analysis revealed a significant effect of school type for females (t(86)=3.83, p=0.001) with single sex educated females having a lower rating of ease of subject than all other students. NB: The study also investigated students' reasons for post-16 subject choices, including ratings of reasons for choosing English literature, mathematics, computing and physics (i.e. differences in importance of reasons between the four subjects). The ratings for each individual subject were not clearly reported, but it was stated that “On the whole, overall ratings of importance for the different reasons did not vary much between the four subjects examined...” (section 5.3.5) RESULTS FROM THE SIXTH-FORM STUDY *Addressing the research aim to investigate students’ reasons for their changing their original A-level choices (fifth-form choices compared with sixth-form choices):* *Author reports that in total 38% of the sample (28% of females and 49% of males) were currently not studying one of the A-level subjects they had chosen in the 5th year, while a further 20% had dropped two of their intended A-level subjects and two students had dropped all three of their original choices.* Reasons for dropping physics and English literature: These subjects were identified as two of the subjects dropped by the highest percentage of intending students. The most frequently given reason for dropping physics was subject difficulty, with five out of 20 students citing this. The next most important reason for dropping physics was preference for another subject (four students). A further three students mentioned that they could do better in another subject or had achieved better GCSE grades in another subject. Two students cited career reasons, in that physics was not relevant or another subject more so, and two had dropped it because they did not want to study four A-levels. Lack of ability, failure to achieve the required grade, loss of interest and lack of integration with other A-level subjects were mentioned by one student each. For English literature, six out of the 22 students who dropped this subject could not take it because of timetable classes, four at the same school. Loss of interest (four students) and having achieved better GCSE grades in other subjects (four students) were also mentioned. Other reasons given by one student each were lack of integration with other A-level subjects, new subject more important or giving a better all-round background, difficulty, heavy workload of subject and failure to achieve the required grade. Two students gave no reason. In addition to giving reasons for changing their original choices, students were also asked if they would have liked to take any other subjects at A-level, and if so, why they did not take

	these subjects. This question attempted to explore the constraints which the students perceived as important influences on their subject choices. For psychology, this A-level was not available at school for two of the subjects who had wished to study it. The other two reasons given were “perception of this class” and “just the way things worked out”. For computing, the main reason for not taking it was not having studied the relevant GCSE (four students). Two of these students mentioned that they had not been aware at the time that the GCSE was not necessary for the A-level. Two students were unable to take the subject at A-level due to a timetable clash with other subjects. Other reasons given were difficulty, lack of ability, lack of interest at the time of choice, lack of relevance to career, preferred other subjects, did not like the teacher and laziness. In terms of physics, of the five students who had wanted to study this subject, two had not done so because they had chosen another preferred subject instead but the other three had been unable to do physics because of subject difficulty, failure to achieve required GCSE grade and lack of preparation - one student had only taken double award science at GCSE level rather than doing all three sciences separately and so felt unable to continue her studies in physics. Four students in the sample, one male and three females, mentioned being deterred from choosing a science subject for A-level because they had taken double award science for GCSE. RESULTS FROM THE SCHOOL INTERVIEW AND IDEX STUDY *Chapter 7 describes the findings of an in-depth exploration (using IDEX analyses and interview material) of subject choice, and issues of gender identify and discipline identity. The following is a summary of the results of this part of the study in relation to the stated research aims:* The two science to non-science changers said that difficulty of science was the reason they changed. (p.120) “Difficulty appeared to have different connotations for each of the science to non-science changers. For the male business changer, difficulty seemed to be defined in terms of the amount of time taken up by science.” (p.136) “Three of the changers described the need to choose between science and non-science subjects for A-level. *Example student quote:* “I would have liked to do history, but the more science subjects the better...” (male optometry changer) … All these students appeared to share the belief that taking all science A-levels was more useful or acceptable than taking a combination, a perception which was shared by other students.” (p.121) “The majority of students stressed their autonomy in making decisions about their educational choices. However, parents were acknowledged as being important sources of advice, information and support. Others mentioned as influences on choice were careers teachers, subject teachers and friends.” (p.122; refers to both science and non-science students) Using the IDEX analyses and interview material, important distinctions were drawn between the two female science non-changers. “These case studies suggest that choice of science may impact upon the identity development of different female students in different ways. For females whose gender identity is important to their sense of self, choice of science may be problematic, particularly if combined with negative attitudes towards women in science.” (p.132) The author noted that “examining physics students as a group without further within-group differentiation may obscure important issues relating to issues of identity.” (p.134) The author summarised the findings from this part of the study as follows: “The generalisability of these findings is obviously limited due to the small numbers of students

	involved but interesting themes and possibilities have been highlighted. The main conclusion to draw is that student groups are not homogeneous and that there may therefore be distinctly different groups of female students within science and of "changers within the changers". Within both science and arts, there may also be students who display identity patterns and values associated with the opposite field although they enjoy fields to a similar degree. In relation to changing choices, careers advice and the concept of natural ability appeared to be important themes. Changing from science may have negative impact for students who feel that they do not fit the mould of arts but also lack the ability to do science." (p.139)
Matthews & Pepper (2007)	Results extracted from the Interim Report (Matthews & Pepper, 2005, pp.42-47), the Final Report (2007, pp.46-50) and Appendix K (2007, pp.17-19). Why students choose mathematics: The authors reported that the case study centres were a rich source of information about why students chose to study mathematics in our interim study, and they built upon this in the final report. In the interim report, the analysis of the case study centres' student questionnaire led the researchers to generate their 'comfort/utility hypothesis'. Although the evidence suggested that both boys' and girls' choice of A-level mathematics were motivated by these factors – of comfort with their ability to cope with the subject, and of the utility of the qualification to their later career and education plans – boys appeared to be more motivated by the usefulness of A-level mathematics for university and subsequent careers. Girls, on the other hand, seemed more motivated by previous enjoyment and their perceptions of success. There was no repeat question in the student questionnaires about the reason for study, but more discussion in the interviews, particularly around the hypothesis formed during the interim study that there may be a tendency for girls to rate being comfortable with their ability to cope as very important, compared with a tendency for boys to stress the usefulness of the qualification. Evidence drawn from these interviews has seemed to support and add nuance to this hypothesis. For boys, university/career plans were by far the most frequently occurring reason cited. For girls, the top three reasons occurred with similar frequencies. They were, in order of frequency: • previous success • university and career plans • enjoyment of the subject. In 2006, the main reason (for AS and A2 students) for studying mathematics was because it would be useful to them for university entrance or for their careers. Enjoyment and ability were also frequently occurring reasons. It was reported that a range of reasons for studying mathematics emerged from the data. The majority of students gave more than one reason. The most commonly occurring reasons, in order of frequency of occurrence, were as follows: Table 22. The frequency of responses by gender (1 is most frequent) BOYS 1.University/career plans 2.Previous success 3.General benefits 4.Enjoyment 5.Complementing other subjects 6.Advice GIRLS 1.Previous success 2.University/career plans 3.Enjoyment

4.Complementing other subjects
5.General benefits
6.Advice

University and career plans were by far the strongest motivator given by boys for choosing mathematics, with the second most popular reason being given far less frequently. In the case of girls, there was much less variation in the frequency of occurrence of the first three reasons.

Boys were significantly more likely than girls to say that they chose mathematics because of their university or career plans. Boys were very slightly more likely to give a reason that mathematics was more generally beneficial to have. However, girls and boys generally expressed this differently. Boys talked about mathematics being a ‘good’ subject to have and mentioned its being impressive on a CV. Girls were more likely to say the subject was ‘useful’.

Girls were significantly more likely than boys to say they had based their choice on previous success. They were twice as likely as boys to say that they chose mathematics because of their enjoyment of the subject. Girls were also more likely than boys to give the reason that mathematics complemented their other subjects.

Only a small number of students said that they chose mathematics because they were advised to do it and these were mainly boys.

The case study centre teaching staff were also asked how far they agreed with the theory that boys are motivated more by the usefulness of mathematics and girls by feelings of security. However, in their response there was a split between those who tended to agree with the hypothesis and those who tended to disagree – several, in fact, objected to the stereotypical nature of the question. Several teachers raised the absence of coursework from A level mathematics as a reason why girls may not be drawn to it.

Other motivating factors
The most common reason non-completing students gave for choosing AS mathematics was that they had enjoyed GCSE or done well at it.

Some AS, A2 and non-completing students described mathematics’ high status as an A level subject.

Many students said that mathematics would be useful to them for university entrance or for their careers, and the most frequently occurring response from AS students was that they had not decided on a university course but believed that mathematics would be a good subject to have on their UCAS form.

Students named a wide variety of university courses and careers for which they thought mathematics would be necessary or relevant. Most commonly mentioned were mathematics courses or teaching, medicine, engineering and finance-based courses or careers in finance.

Students were finding that their mathematics work helped them with some of their other A level subjects, especially science and business-based courses.

Another common reason given for doing mathematics was that they were good at it, or that they had got a good grade at GCSE. A smaller number of students said it was because they enjoyed the subject. Amongst those students studying further mathematics, the students’ enjoyment of the subject was the most frequently stated reason, followed by future plans, and being good at mathematics.

The most common reasons the non-completing students gave for taking up AS mathematics were that they enjoyed GCSE mathematics or that they got a good GCSE grade.

A2 STUDENTS
The most frequently occurring reason A2 students gave for studying mathematics was that it

	would be useful to them in the future, chiefly for study or career purposes but sometimes in a less specific way. Some students thought that it was a high status subject which 'looks good on a CV'. Enjoyment and ability were also key reasons and were often linked to comments about their choice of future career. AS STUDENTS AS students often had a variety of reasons for studying mathematics. The vast majority of students said they were studying mathematics because it was a useful subject. This was related to either their choice of career or university degree, or more general. Students demonstrated a perception that mathematics was applicable to a range of degree courses and careers. A few also noted that it was generally well thought of and 'looks good on a CV'. Planned courses and careers included mathematics teaching, sciences, medicine and related courses, and business or finance-based courses. A few students had not decided what course they wanted to do, or were planning to take a course for which mathematics was not essential, but said that doing mathematics did not restrict their choices and looked good on a UCAS form. The next most common reason given for doing mathematics was that they were good at it, or that they had got a good grade at GCSE. A smaller number of students said it was because they enjoyed the subject. A similar number said they were doing it because it was a good fit with their other subjects. This was usually because they thought it would complement and support their other subjects but sometimes students chose it as a contrast to other, essay based subjects. Many students expressed a combination of the reasons given above. Only two said they were doing mathematics because they were advised to, one of these because he would need it for university. One student said he was doing it only because his parents had said he had to. One was unable to do the subject he wanted to because of the timetabling. Another said he was doing it because he would be able to get help from his brother. FM STUDENTS For further mathematics students, the most frequently stated reason for studying mathematics was enjoyment. This was closely followed by future plans and then being good at mathematics. A small number of students said they were taking it because they wanted to have an extra AS. A few students said that they preferred mathematics to other subjects and so decided to do more of it rather than choose something else. Non-completers STUDENTS The most common reasons the non-completing students gave for taking up AS mathematics were that they enjoyed GCSE mathematics or that they got a good GCSE grade. Three students said they did it because teachers persuaded them and three because of parental pressure. A few said they had thought it would be a good qualification to have on their CV. Several others said that they did it to help with their applications to university. Why students don't choose mathematics: This was an area explored in the interim report in detail and there was no further work carried out with these students in the final year of the study, in favour of new areas of enquiry. The information discussed here therefore stems from the interim report only. Students who had achieved well as GCSE in mathematics (at least a grade B) were asked why they had decided not to pursue their study of mathematics. Many students said they perceived it to be a difficult subject - 'mathematics is notoriously difficult' - and therefore it would be difficult to get a high grade. Many students felt that they would need to have more confidence in their mathematical abilities in order to study the subject at a higher level. These students were put off by reports of the level of difficulty experienced by previous students who had struggled despite getting good GCSE results and had told them that mathematics is the hardest subject. For others, seeing the number of low grades (D and E) in the schools' published results put them off the subject.

A small number of students had been discouraged from studying mathematics by their teachers, with the teachers pointing out that it is a big jump from GCSE. One student said that the college does not promote mathematics and it is seen as a specialist area to support subjects like physics. A small but significant number said that they might have studied mathematics if their teachers had given them more encouragement.

The perception of mathematics being a demanding subject meant that many students decided not to study at AS because they thought that it would take up too much of their time and many of these students felt that their strengths did not lie in the subject area. A significant number of students mentioned that they had taken intermediate GCSE and did not think that this would have given them enough of a foundation to study at AS.

A small number of students said that they found mathematics to be a dull subject and they couldn’t see the use of mathematics in their future life, for their course or career plans, instead other subjects were deemed to hold more importance to them. One student chose physics over mathematics because it is a more practical subject and experiments emphasise what is being learnt. Some students would have been more interested in taking the subject if there were different levels that one could study at, similar to the GCSE structure, or if you could choose to focus on a few areas of interest in detail. One student viewed mathematics to have no structure, unlike history or English. Other students thought that a lot of the content appeared to be ‘useless’. Interestingly, many would have studied it if it had been a university entrance requirement, or needed for a future career. One group said that A level mathematics impresses people and that if this image had been pushed more then they would have considered studying it.

Mathematics is viewed by a number of students as needing to be more fun, to have more class interaction and more use of the computer. There is a feeling that mathematics needs to be made more practical, for example through the use of games and puzzles. One group said that there were too many interesting options available to take as a fourth AS which made them discount taking mathematics as their fourth option and one or two students would have considered mathematics as a fifth option had their school/college allowed it. Many students mentioned that they would need financial incentives to study mathematics.

One group said that if the school had given them encouragement to take the subject such as an induction lesson then they might have changed their minds. Their perceptions of the subject as being difficult put them off. A significant number would have liked to have had more detail about the course content at AS level when given information about studying A level subjects.

The large-scale questionnaire ‘Further comments’ section yielded a number of comments about why students may not continue with mathematics after GCSE. GCSE mathematics was thought by some respondents to be demoralising to students who completed the course without a good grasp of the subject, and the low grade-boundaries were thought to perpetuate this. It was suggested by a number of respondents that the questions should be made easier and the grade boundaries raised to make GCSE mathematics a more positive experience for students.

There were also some strongly argued comments suggesting the reduction or even abandonment of the coursework requirement at GCSE, particularly the data handling unit. This was said to put students off progressing to AS level mathematics, one respondent referred to the coursework as a ‘millstone’.

McCarthy & Moss (1990)

Table III: Reasons for choosing CDT: Technology (p.210)

	GCSE	A level	All males	All females
Interest in new subjects	5	4	5	4
Not interested in others on offer	3	0	1	2

Told to by parents	0	0	0	0
Friends opted for the subject	0	0	0	0
Do not care what option is followed	0	0	0	0
Believe it to be useful in future	22	8	18	12

The influence of years 1-3 on subject choice: "When the pupils were asked how much they enjoyed the CDT work in the lower school and whether their earlier experiences had influenced their option choice for GCSE their responses were very positive... However only 37% of all pupils (50% of all girls) indicated that this had had a strong influence on option choice in year four." (p.210)

Mendick (2006)

In the search for patterns in the data the author grouped the 43 students by their main reason for choosing mathematics. The following shows the outcome of this process.

	m/c girls	m/c boys	w/c girls	w/c boys
For chosen career and enjoyment	2	3	3	1
For enjoyment	5	4	0	2
For chosen career and not enjoyment	1	0	3	1
To prove something to others	0	1	2	5
To prove something to themselves	1	0	2	0
Unclear	0	0	1	2

m/c: middle class
w/c: working class

There were some overall patterns:
*There were more middle class students (86 percent, 18 out of 21) than working class students (36 percent, 8 out of 22) who chose mathematics because they enjoyed it.
*There were more girls (42 percent, 8 out of 19) than boys (17 percent, 4 out of 24) who chose mathematics because of specific career goals. However, male students dominated the employment related category: 'to prove something to others'. One group, 'to prove something to themselves', was entirely female (16 percent, 3 out of 19).
*Those who enjoyed mathematics and evidenced the strongest identifications as mathematicians were exclusively male (25 percent, 6 out of 24).

The author noted that these generalisations obscure the variations of gender and class within the groups and the ways that there are no simple relationships between someone's demographic profile and their identification with mathematics. The author also noted that these classifications were not easy to craft and she had to make choices about which factor she felt emerged most strongly from their interviews. Students in the same section may tell very different stories. She added that while divisions into male or female were relatively straightforward, divisions into working or middle class were much less so. She added that many important elements, notably family, friends and teachers, were absent from the table. These featured in most interviews but were rarely given as the explicit and never, in her readings, as the main reason for a student's choice of mathematics.

Munro & Elsom (2000)

Results from the study (direct quotations)

1. The teachers, career advisers, and pupils reported that up to Year 9, pupils in these schools usually enjoyed science, but many (particular girls) seemed to lose interest and/or confidence during Year 10. Whilst very few pupils expressed regret that they had to study science up to the end of Key Stage 4, it appeared that unless they were one of the few 'born scientists' or they knew they needed sciences for the career for which they were aiming, they were unlikely to maintain commitment if they found the course hard or dull.

	2. From discussions with the Year 9 and Year 11 pupils, it would appear that science in our case study schools was usually enjoyed by pupils up to Year 9 and that few pupils regretted that they had to study science up to the end of KS4. 3. Of the Year 11 pupils who planned not to take science subjects beyond GCSE most said they had decided by the end of Year 10, based mainly on their experience of science in the classroom. Those who had decided to do science were either very keen on the subject, or in some cases had found out about a particular career that had caught their interest and for which they knew they needed science - medicine being a common example. 4. Neither the idea of choosing science post-16 because of the ensuing flexibility of career and course choice, nor the concept of the value of the transferable skills gained from science subjects, had much appeal to pupils. Some did give examples of family or friends who had used science qualifications to enter other work areas. But as factors in their own decision-making about science, these concepts seemed less immediate than their own experience of science, and less powerful than knowing they needed the subjects for a particular career they were interested in. 5. The perceived mathematical content of other A-level science courses (particular physics) was also mentioned as a factor affecting the decisions of pupils who were not confident in science. 6. Where there was a sixth form in their school, Year 11 pupils seemed aware of the success rates in different subjects of previous years' cohorts, and in some schools this affected their choice - 'I was going to do biology but the results last year were so bad I have chosen something else'. 7. Pupils' reactions to their experience of science in the classroom were a major factor in their interest and enjoyment of science and their wish to continue further. 8. A few pupils mentioned parental pressure to do specific subjects, most reported that parents took the same line as the schools in encouraging them to follow their interest. Whilst a few pupils mentioned parental pressure to do specific subjects, most did not. 9. The pupils reported that they found interviews with the career advisers more helpful when they wanted confirmation of a career choice and more information about routes towards a goal already chosen. Pupils from both the Year 9 and 11 group said they would have liked more career suggestions from the adviser. 10. The pupils' perceptions of the contrasting life styles of 'scientists and technologists' and of 'management consultants and media people' were thought by teachers, and some pupils too, to play a significant role. 11. Science teachers appeared to have a major influence on pupils' motivation towards enjoyment of science through the pupils' experience of science in the classroom and through extra-curricular activities initiated by science departments.
Reid & Skryabina (2002)	S2 (age 13) choice of 'Standard' grade subjects Two main factors influenced their choice of physics: 1. Usefulness for a further career (44% indicated this) 2. Interest in the subject (29% indicated this) S4 (age 15) choice of 'Higher' grade subjects Four main factors influenced their choice of physics: 1. Enjoyment of the subject (69% indicated this) 2. Good grades in the subject (56% indicated this) 3. Interest in the subject (44% indicated this) 4. Usefulness for a career (31% indicated this) (p.77)
Sears (1997)	"There were two significant differences between the double award students and the others over why they chose their A-levels. More double award students said they were attracted by potential salaries in science jobs and more said they were put off by their lack of enjoyment at GCSE (although this had not made a difference in A-level uptake)." (main report of the study: 1997, p.4)

	"Students from a physical science or a double award background were also more likely to choose for career reasons." (main report of the study: 1997, p.5) "In the initial analysis of the social norm, those who ended up choosing arts were more likely to be influenced by friends..." (main report of the study: 1997, p.7) "Analysis by A-level subject reveals one or two interesting features. Physical scientists are more likely to have been encouraged by mathematics teachers than other groups. Similarly they were also more influenced by their technology teachers." (linked report: Sears, 1993, pp.369-370)
Sharp et al. (1996)	For schools, six characteristics were investigated to see if they had a significant relationship with take-up: (1) School-type was significantly related to take-up for mathematics, physics and chemistry, but not biology. Take-up for these three subjects was highest in independent and grammar schools and lowest in comprehensive and secondary modern schools. (2) Single-sex schooling was significantly related to take-up for all for subjects. For mathematics, physics and chemistry, boys' schools had the highest take-up. For biology, take-up was highest in girls' schools. This relationship is consistent with the general patterns of take-up for mathematics and science A-levels among male and female students. (3) A proportion of pupils eligible for free school meals was significantly related to A-level take-up in all four schools. This measure is an indicator of the level of economic deprivation among the families served by the school. Schools with the highest take-up for mathematics and science subjects had the lowest proportion of students eligible for free schools meals. (4) The proportion of students achieving five or more A*-C grade GCSEs was used as a measure of the academic attainment of the school. This was significantly related to take-up for all four subjects, with higher achieving schools having the highest take-up. (5) The geographical region in which the school is located was not related to take-up for mathematics, chemistry or biology A-level. For physics, comprehensive and secondary modern schools located in the South West and East Midlands had a significantly higher take-up than similar schools located elsewhere. (6) There was no significant relationship between the religious denomination of the school and A-level take-up for any of the three science subjects, but for mathematics, take-up was highest in Church of England (and Methodist) schools. Similar analyses were carried out for the responding colleges. Three college characteristics were investigated: (1) The size of the college was significantly related to take-up for A-level in all three science subjects, but not in mathematics. Smaller colleges (i.e. those with 550 or fewer students) had the highest take-up for physics, chemistry and biology. (2) Colleges located in the South West and East Midlands had significantly higher take-up for physics and biology A-level than colleges located elsewhere. 3) Sixth-form colleges had a significantly higher take-up for chemistry A-level than tertiary colleges. The relationship between take-up and school/college characteristics was taken into account before looking at relationships between take-up and other factors: the A-level experience of students; their experiences in mathematics/science pre-16; and the characteristics of the mathematics/science department. This was designed to ensure that the high take-up group consisted of schools/colleges where take-up was high in relation to other institutions of a similar type, location, GCSE results, etc. For physics, the relationship between school type and take-up was so strong that this necessitated separate analyses for two groups of schools (i.e. independent and grammar; comprehensive and secondary modern). Findings related to the students' A-level experiences: (1) There was a significant relationship between the size of A-level teaching groups in schools and take-up of all four subjects. In colleges, there was a significant relationship between the size of A-level teaching groups and take-up for chemistry and biology, but not for physics or mathematics. Institutions with high take-up had larger A-level teaching groups.

	However, this association is most probably the result of higher take-up, rather than a cause of it. (2) The proportion of 1995 A-level entrants in schools who passed physics, chemistry and biology was significantly related to higher take-up for A-level in the following academic year. In physics there was a relationship for this variable among comprehensive and secondary modern schools only. There was no such relationship for mathematics in schools or for take-up in any of the four subjects in colleges. (3) There was no significant relationship between take-up in any of the subjects and modular A-levels, although there were some relationships between take-up and A-level courses offered by certain examination boards. (4) There was no significant relationship between take-up in any of the subjects and the requirement made in some schools and colleges for students studying science A-levels to take A-level mathematics. Findings related to the students' pre-16 experiences: (1) The practice of setting by ability for science pre-16 was significantly related to higher take-up for physics in comprehensive and secondary modern schools, but there was no such relationship between setting by ability for science or mathematics and A-level take-up in the other analyses. (2) A-level science take-up was not significantly related to teaching time allocated for science pre-16. The only significant relationship between teaching time for a subject pre-16 and take-up at A-level was that schools which had devoted a greater proportion of teaching time to mathematics in year 10 had a higher take-up for mathematics A-level. (3) There was a significant relationship between the proportion of students who had taken separate science GCSEs and higher take-up for physics, chemistry and biology A-level subjects. However...it was much more common for students in independent and grammar schools to have taken separate science GCSEs, and it may have been the type of school, rather than the type of science GCSE which was the main influence on take-up. For physics, where separate analyses were carried out for different types of school, A-level take up was significantly higher in those independent and grammar schools in which a higher proportion of A-level physics students had taken separate science GCSEs. (4) For colleges, the type of GCSE science course...was not significantly related to take-up of any of the science subjects (NB: very few of the science A-level students had taken separate science GCSEs). Findings relating to the characteristics of the mathematics/science departments: (1) There was a significant relationship between the proportion of the institution's teaching staff who taught mathematics, chemistry and biology, and take-up for these subjects at A-level. In schools and colleges with high take-up, the proportion of staff teaching these subjects tended to be larger. This association is probably the result of higher take-up, rather than a cause of it. (2) The proportion of subject teachers with degree-level qualifications in their subject was related to higher A-level take-up for biology and for physics in independent and grammar schools. Colleges where a higher proportion of subject teachers had degree-level qualifications in physics had significantly higher take-up for A-level physics. (3) There was a somewhat surprising relationship between colleges which had a slightly lower proportion of A-level biology teachers with degree-level qualifications in biology and high take-up for biology A-level. (4) The stability of staffing in the mathematics and science departments (defined as the proportion of teachers who had worked at the school or college for five years or more) was not significantly related to take-up for mathematics or any of the science subjects. Findings relating to influences on take-up for female and male students: Initial analyses had revealed that take-up for mathematics, physics and chemistry was significantly higher in single-sex boys' schools, and take-up for biology was significantly higher in girls' schools. These analyses had been carried out on the basis of all students in years 12 and 13 (i.e. without distinguishing between female and male students). In order to consider gender-related patterns of take-up further, two variables were investigated in relation to patterns of take-up for mathematics, physics and chemistry A-levels for female students only and for A-level biology among male students only. The variables investigated were: education in single-sex as opposed to co-educational schools and the proportion of

	male and female mathematics and science teachers in schools and colleges. (1) Take-up for mathematics, physics and chemistry was not significantly higher among female students educated in girls' schools than among female students in co-educational schools, nor was take-up for biology higher among male students educated in boys' schools. (2) The only significant finding for single-sex schooling was that there was a higher take-up for physics among female students in the sixth forms of comprehensive boys' schools. (A possible explanation for this is that female students may well join the sixth forms of boys' schools in order to study physics.) (3) The proportion of female mathematics or science teachers was not related to take-up among female students for mathematics, chemistry or physics in comprehensive and secondary modern schools. (4) There was a significant relationship between the proportion of female science teachers and higher take-up for physics among female students in independent and grammar schools. (5) There was no relationship between the proportion of male science teachers and take-up for biology among male students in schools. (6) There was a significant relationship between the colleges with a higher proportion of female mathematics teachers and higher take-up for A-level mathematics among female students. (7) There were no significant relationships between take-up of science A-levels among male and female students in colleges and the proportion of male and female science teachers. (pp.3-8) "Students are thought by heads of mathematics and science departments to take mathematics and science subjects because they enjoy the subject, want to pursue a career or course of study which requires the subject, and are influenced by the enthusiasm of the teacher. In addition, awareness of the A-level grades achieved in the subject by former students is felt to be of some importance in influencing students' decisions to take mathematics/science subjects." (p.10) See Tables 4.1.1, 4.2.2 (p.11) "Heads of mathematics and science agreed that the main factor discouraging students from taking mathematics/science courses post-16 is that students perceived these subjects to be more difficult than other A-level choices." (p.12) See Tables 4.2.1, 4.2.2 (pp. 12-3) "Heads of mathematics felt that female students were encouraged to take mathematics A-level if they had good female role models and had experienced success in mathematics pre-16. Science teachers felt that the most important reason why females take physics/chemistry and males take biology is their wish to pursue a higher education course or career in a related area. The presence of female physics and chemistry teachers was also considered to be an importance factor in encouraging female students to take these subjects. Females were reportedly discouraged from taking mathematics, physics and chemistry by their perception and/or experience of difficulty of the subjects. Subject stereotypes were also thought to be influential. Mathematics, physics (and to a lesser extent chemistry) were reportedly perceived by students to be "boys' subjects", and biology a "girls' subject"… In the majority of cases respondents were reporting increased recruitment. The main reasons given for this were: *the introduction of modular A-level courses, which were reported to be popular with students in all four subjects; *in chemistry and biology, that students had been particularly successful in GCSE science, compared with previous years; *in colleges, increased recruitment for the three sciences was commonly ascribed to successful marketing of the science department or of the colleges as a whole." (pp. 13-4)

Spielhofer et al. (2002)	1. Entry to Design and Technology: Graphics GCSE Results: Odds ratios (significance level) KS2 average level < 3 0.785 (0.0%) Sex (girls or boys) 0.718 (0.0%) Girls' school 1.127 (0.0%) Small school 0.928 (0.0%) Grammar school 0.617 (0.0%) The other background variables, boys' schools, large schools, and schools with sixth forms were not statistically significant at the 5 percent level. 2. Entry to Design and Technology: resistant material GCSE Results: Odds ratios (significance level) KS2 average level < 3 0.742 (0.0%) Sex (girls or boys) 0.237 (0.0%) Girls' school 1.591 (0.0%) Small school 1.168 (0.0%) Grammar school 0.364 (0.0%) The other background variables, including boys' schools, large schools, and schools with sixth forms were not statistically significant at the 5 per cent level. 3. Entry to physics GCSE Results: Odds ratios (significance level) KS2 average level < 3 0.768 (4.0%) Sex (girls or boys) 0.802 (0.0%) Boys' school 2.894 (0.0%) Girls' school 1.394 (0.0%) Small school 0.747 (0.0%) Large school 1.070 (0.3%) Grammar school 4.835 (0.0%) School with 6th form 0.875 (0.0%) 4. Entry to chemistry GCSE Results: Odds ratios (significance level) Sex (girls or boys) 0.808 (0.0%) Boys' school 2.803 (0.0%) Girls' school 1.329 (0.0%) Small school 0.772 (0.0%) Large school 1.085 (0.0%) Grammar school 4.773 (0.0%) School with 6th form 0.856 (0.0%) Low KS2 average level was not statistically significant at the 5 per cent level. 5. Entry to biology GCSE Results: Odds ratios (significance level) Sex (girls or boys) 0.822 (0.0%) Boys' school 2.800 (0.0%) Girls' school 1.314 (0.0%) Small school 0.784 (0.0%) Large school 1.065 (0.5%) Grammar school 4.450 (0.0%) School with 6th form 0.834 (0.0%) Low KS2 average level was not statistically significant at the 5 per cent level.

	6. Entry to French and German GCSE Results: Odds ratios (significance level) KS2 average level<3 0.442 (0.0%) Sex (girls or boys) 1.828 (0.0%) Girls' school 0.797 (0.0%) Large school 0.905 (0.0%) School with 6th form 0.904 (0.0%) Grammar school 1.256 (0.1%) The other background variables, boys' schools and small schools, were not statistically significant at the 5 per cent level. 7. Entry to double rather than single science Results: Odds ratios (significance level) KS2 average level<3 1.111 (0.0%) Sex (girls or boys) 0.865 (0.0%) Boys' school 0.747 (0.0%) Small school 0.895 (0.0%) Large school 1.077 (0.0%) School with 6th form 0.842 (0.0%) The other background variables, including girls' schools and grammar schools were not statistically significant at the five per cent level.
Springate et al. (2008)	Overview of factors affecting subject choice in physics and chemistry (section 3.1, p.12) "There was a clear hierarchy of influences that emerged from the ranking exercise carried out by individuals and focus groups. The factors can be split into three groups of influence: *High influence factors were enjoyment of chemistry and physics, future ambitions, perceptions of careers with a physics or chemistry degree, and the relevance of physics/chemistry study to life *Medium influence factors were the way physics and chemistry are taught, physics and chemistry teachers, images of scientists and the work they do, and family *Low influence factors were the difficulty of physics/chemistry, role models, careers advisors and peers." Enjoyment of physics and chemistry: "Enjoyment was one of the most important influences on decisions across all ethnic groups, and appeared to be a slightly greater influence for females than males...Some young people suggested that their enjoyment was influenced by their ability in the subject: '...if you're good at it then you enjoy it because you're good at it.' (Chinese male, A-level chemistry)." (p.13) Future ambitions: "The future career ambitions of interviewees was one of the most important influences across all the ethnic groups on decisions to study physics and chemistry. Whilst some individuals were studying physics or chemistry at degree or A-level with the aim of a career related to physics or chemistry, most saw them as a stepping stone at A-level to a different career. For example, many individuals were studying chemistry as it was a prerequisite for studying subjects such as medicine, pharmacy and dentistry at university. Others were studying physics at A-level as they wanted to go into engineering. However, it was notable that this influence appeared to be stronger for those studying chemistry than for those studying physics. Physics students were less likely to see study of the subject as a stepping stone to another career." (p.14) Perceptions of careers with a physics or chemistry degree: "Perceptions of careers available with a physics or chemistry degree was one of the most important factors influencing black African, Indian, Pakistani and Bangladeshi interviewees. It was a slightly less influential factor for Chinese and black Caribbean interviewees. This influence tended to have a negative effect on decisions, influencing people away from

	chemistry and physics... Those with...positive perceptions of careers were much more likely to be undergraduates than A-level students, who correspondingly were more likely to have negative perceptions of potential careers." (pp. 14-5) Relevance of physics and chemistry study to life: "The perceived relevance of physics and chemistry to life was one of the most important influences on the decisions of black African and Chinese interviewees to study chemistry and physics, and a slightly less influential factor for the other ethnic groups. Issues of relevance were most likely to dissuade interviewees from studying chemistry and physics... Those that had positive perceptions regarding the relevance of physics and chemistry were more likely to be undergraduates than A-level students." (p.15) Chemistry and physics teachers: "Chemistry and physics teachers/lecturers are an influence on young people's decisions to study physics and chemistry, and one of the most important influences acting on Chinese interviewees... 'Because [the teacher is] excited about it then you're just more keen to know what she's excited about.' (Indian female, A-level, Chemistry) ...the main focus of comments was on teachers at school who had influenced interviewees to study physics and chemistry..." (p.16) Images of scientists and the work they do: "Undergraduates were more likely to have positive images of scientists and their work than A-level students." (p.16) Family: "Family was an influence on young people's decisions regarding physics and chemistry study, and was one of the most important influences for Pakistani interviewees." (p.17) "Family is seen as a middle-ranking influence, most often ranked in the middle third of the influences detailed earlier. It is not perceived to be as important as influences such as enjoyment of the subject and perceptions of careers, but is more influential than factors such as peers and role models. This was the case across all of the ethnic groups involved in the study except Chinese and Bangladeshi interviewees... A small number, whilst suggesting that their parents had little influence on their decisions, felt that the influence may have been subconscious, and something that they were not aware of. One respondent explained that: 'I don't know if it has, I don't think it has, I really don't think it has, but maybe it has without me realising it, subconsciously' (Black African female, A-level, chemistry)." (p.20) "In terms of subject choices, families discouraged their children from taking arts subjects at A-level, as they were generally not seen to lead to as good a career... As one interviewee commented: 'I think from an early age my parents put a heavy emphasis on the academic subjects...as in an emphasis on maths and sciences' (Chinese male, A-level, chemistry) ...this tended to be the case at A-level choice, rather than degree level." (p.21) "Most parents did not encourage their children towards careers in physics and chemistry, even though many saw them as prestigious subjects to study at A-level. This was because families were not aware of any good career opportunities related to chemistry or physics." (p.22) See pp.22-7 for further discussion about the influence of the family and for various quotations by A-level students on this issue. See also p.51. Peers: "The findings from this research suggest that peers do have some influence on young people's choices... However, in the majority of cases peers are not one of the most dominant influences... The influence of role models appears to differ slightly by gender; with A-level female students being less likely than their male peers to report having chemistry and physics role models and more likely to identify a lack of chemistry and physics role models." (p.32) "Overall, although a lot of A-level students spoken to enjoyed chemistry and/or physics, there was considerable consensus in terms of attitudes towards careers in these subjects,

	perceiving them as restrictive, isolating and insufficiently lucrative and stable." (p.35) Role models: "...a significant proportion of A-level students also felt that there was a lack of relevant and visible chemistry and physics role models... A-level female students were particularly unlikely to have chemistry and physics role models... and were more likely than their male peers to report a lack of role models in chemistry and physics." (p.38)
Tebbutt (1993)	"Interviews with a 5% sample, the secondary technique, reinforced both this impression of complexity and the importance of interest as a determinant of subject choice." (p.27) "...the main reason given for choosing to take mathematics or physics at A level was previous success and interest in these subjects." (p.35) "Since there is also strong evidence that interest is a major determinant of subject choice, both for A levels..." (p.36)
Vidal Rodeiro (2007)	"There were some differences as to students' reasons for choosing particular subjects. For example, students tended to choose Mathematics and Science subjects in terms of their usefulness for a future job or career. On the other hand, in subjects such as Psychology, Media Studies, Music, History or Design and Technology, reasons relating to interest and enjoyment outnumbered those relating to usefulness for the future." (p.6) "In subjects such as Physics, Chemistry, Mathematics, Further Mathematics, Business Studies, ICT/Applied ICT, English and Accounting usefulness for a future career featured as the most important reason. This reason also featured strongly in relation to Law, Economics, Spanish, PE/Sport and Health and Social Care. By contrast, in Psychology, Sociology, History, History of Art, Art & Design, Media Studies, Film Studies, Philosophy, Religious Studies, Music, Dance, Drama, Communication Studies, Design & Technology, Government & Politics and Travel & Tourism reasons relating to interest and enjoyment outnumbered those relating to ability or usefulness for a career. Ability featured least in the cases of Psychology, General Studies, Law, Accounting, Communication Studies, Critical Thinking, Film Studies and History of Art." "Further analyses on the reasons for AS/A level choices were carried out. The AS/A level subjects were grouped into five areas: English, Languages, Science/Maths, Arts and Social Sciences/Humanities. More details of the subject areas can be found in Appendix G. The proportions of times each reason was rated as 'Very important' were computed for each subject area and are reported in Table 22. The reasons that have been highlighted in grey scored higher than the average for all subjects. There is a contrast between the Arts and the Sciences. Students choosing the Arts have higher than average ratings for enjoyment, interest and ability in the subject and less than average ratings for the more pragmatic criteria relating to higher education and to future employment. Students choosing science/maths subjects have higher than average ratings for usefulness." (pp.31-2) Table 22: Importance of reasons for choosing subject areas: reason was rated as "very important" (p.33)

	Arts	English	Languages	Science/ mathematics	Social science/ humanities
Reason for choosing science/mathematics	Mean/S.D.	Mean/S.D.	Mean/S.D	Mean/S.D.	Mean/S.D.
Thought I would do well in this subject	89.9, 4.7	86.1, 7.1	87.9, 1.4	85.9, 5.1	79.4, 13.0
Thought it would be an interesting subject	93.9, 1.9	87.1, 4.1	89.6, 4.8	82.4, 5.0	84.7, 16.7
Thought it would be an easy subject	28.0, 7.8	23.0, 7.8	28.9, 2.7	27.8, 7.6	25.3, 7.4

Thought it would be useful for career	74.3, 6.5	78.0, 4.8	72.0, 12.6	80.7, 8.4	69.9, 14.8
Subject is requirement for university entry	45.8, 8.4	47.4, 7.6	39.4, 9.2	56.6, 13.3	38.7, 12.9
New subject and sounded exciting	50.4, 25.6	30.3, 28.7	7.0, 4.6	29.1, 17.6	60.2, 25.3
School put pressure on me	5.9, 2.6	6.7, 1.0	5.3, 1.9	8.0, 4.4	8.4, 3.9
Advised to take this subject	32.4, 10.4	37.6, 5.9	30.0, 4.2	37.6, 7.0	30.0, 6.0
My friends are taking this subject	11.3, 3.9	9.1, 2.4	5.5, 1.3	10.3, 2.1	11.7, 3.2
I like the teacher/teacher was good	55.8, 8.0	52.6, 5.0	47.2, 8.4	39.1, 3.2	45.5, 5.9
Subject fitted well with my timetable	28.6, 11.2	28.6, 5.1	11.9, 5.3	26.8, 7.8	28.3, 6.4
Needed this subject to 'complete numbers'	9.8, 4.2	14.3, 11.1	3.7, 2.0	15.3, 7.6	14.7, 4.6
Thought it was a good subject to have	75.4, 5.2	82.8, 7.6	80.1, 15.6	86.2, 5.0	76.4, 11.6
Thought I would enjoy this subject	94.7, 3.5	86.8, 5.6	91.8, 3.2	83.8, 4.2	83.8, 15.7

Table 39: Effects of background variables on the probability of taking at least two science/mathematics subjects (p.62)

Variable	Coefficient	Standard error	Odds ratio
Constant	-2.724	0.127	
Gender: male	0.987	0.066	2.7
Ability: medium	0.983	0.068	2.7
Ability: high	2.068	0.092	7.9
Social class: higher managers	-0.266	0.111	0.7
Social class: lower managers and professionals	-0.173	0.081	0.8
Social class: intermediate workers	-0.125	0.088	0.9
Social class: routine and manual workers	-0.085	0.104	0.9
Social class: unemployed	-0.061	0.166	0.9
School type: FE/Tertiary college	0.246	0.177	1.3
School type: Grammar school	0.450	0.232	1.6
School type: Independent school	0.203	0.205	1.2
School type: Sixth Form college	0.338	0.345	1.4
Town and fringe	0.069	0.113	1.1
Village	0.152	0.120	1.2
Hamlet and isolate dwelling	0.020	0.159	1.0
Ethnic group: Black African	1.055	0.208	2.9
Ethnic group: Black Caribbean	-0.001	0.353	1.0
Ethnic group: Black Other	0.052	0.649	1.1
Ethnic group: Chinese	1.922	0.245	6.8
Ethnic group: Mixed	0.448	0.173	1.6
Ethnic group: Indian	0.959	0.138	2.6
Ethnic group: Pakistani	1.113	0.163	3.0

Ethnic group: Bangladeshi	0.248	0.257	1.3
Ethnic group: Any other ethnic group	1.040	0.188	2.8
Advice	-0.063	0.081	0.9
Advice: Parents	0.126	0.107	1.1
Advice: Brothers and/or sisters	-0.070	0.108	0.9
Advice: Teachers in the secondary school	-0.014	0.109	1.0
Advice: School leaflets	-0.070	0.143	0.9
Advice: Other students/friends	-0.383	0.107	0.7
Advice: University admission tutors	0.797	0.180	2.2
Advice: Speakers from higher education	-0.359	0.167	0.7
Advice: Speakers from employment	-0.067	0.176	0.9
Advice: Open day/career events	-0.008	0.127	1.0
Advice: Internet	0.576	0.115	1.8
Advice: Guidance at the centre	-0.222	0.130	0.8
Advice: Interview at the sixth form centre	-0.099	0.118	0.9

Table 40: Effects of background variables on the probability of taking at least one foreign language (p.64)

Variable	Coefficient	Standard error	Odds ratio
Constant	-2.803	0.169	
Gender: male	-0.812	0.104	0.4
Ability: medium	0.800	0.148	2.2
Ability: high	1.771	0.142	5.9
Social class: higher managers	-0.194	0.145	0.8
Social class: lower managers and professionals	0.015	0.105	1.0
Social class: intermediate workers	-0.226	0.127	0.8
Social class: routine and manual workers	-0.387	0.170	0.7
Social class: unemployed	-0.094	0.276	0.9
School type: FE/Tertiary college	-0.488	0.224	0.6
School type: Grammar school	0.669	0.252	1.9
School type: Independent school	0.877	0.220	2.4
School type: Sixth Form college	0.187	0.403	1.2
Ethnic group: Black African	-0.204	0.343	0.8
Ethnic group: Black Caribbean	0.459	0.420	1.6
Ethnic group: Black Other	-0.440	1.067	0.6
Ethnic group: Chinese	-0.416	0.338	0.6
Ethnic group: Mixed	0.161	0.222	1.2
Ethnic group: Indian	-0.596	0.210	0.6
Ethnic group: Pakistani	-1.134	0.321	0.3
Ethnic group: Bangladeshi	-2.544	1.114	0.1
Ethnic group: Any other ethnic group	-0.055	0.261	0.9
Town and fringe	0.070	0.141	1.1
Village	-0.115	0.151	0.9
Hamlet and isolate dwelling	-0.253	0.201	0.8
Advice	-0.074	0.120	0.9
Advice: Parents	0.145	0.147	1.2
Advice: Brothers and/or sisters	-0.160	0.140	0.9

	Advice: Teachers in the secondary school	0.334	0.148	1.4
	Advice: School leaflets	0.196	0.172	1.2
	Advice: Other students/friends	-0.155	0.135	0.9
	Advice: University admission tutors	-0.022	0.223	1.0
	Advice: Speakers from higher education	0.144	0.217	1.2
	Advice: Speakers from employment	-0.449	0.172	0.6
	Advice: Open day/career events	0.079	0.146	1.1
	Advice: Internet	0.079	0.165	1.1
	Advice: Guidance at the centre	0.079	0.165	1.1
	Advice: Interview at the sixth form centre	-0.217	0.158	0.8

Wikeley & Stables (1999)	"In subjects chosen by more than five pupils of each gender, the following boy/girl differences were found, at beyond the 0.05 level. Boys were more likely than girls to choose double science because it was useful (p = 0.04), and technology also because it was useful (p=0.002). Girls were more likely than boys to choose modern languages because they were useful (>0.05) and for the language itself - both content and process (p=0.02). Girls were also more likely than boys to choose technology because of the nature and content of the subject (significance > 0.01)." (p.290)

Appendix F: References

F.1 References used in the text of the technical report

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