



**The factors affecting A-level and
undergraduate subject choice in physics
and chemistry by ethnic group**

May 2008

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Acknowledgements

The research team would like to thank all the school and university staff who helped us to set up the interviews and focus groups with young people. We are also very grateful to the young people themselves for giving up their time to be interviewed, and for telling us about the influences on their decisions to study chemistry and physics.

We would like to thank the Institute of Physics (IoP) and the Royal Society of Chemistry (RSC) for their advice and support throughout the project. Finally, we would like to thank Julie Thompson, Carol Wilkin and Sarah Harland, who made significant contributions to the research.

May 2008

Executive Summary

Introduction

Much research has shown that, in recent years, the popularity of science subjects at A-level and consequently in higher education has declined (particularly so for chemistry and physics rather than biology) (e.g. Stagg *et al.*, 2003; Hobsons Group, 2006). The issue may be particularly endemic for ethnic minority groups. A recent report, conducted for the Royal Society of Chemistry and the Institute of Physics, investigated the representation of ethnic groups in chemistry and physics (Elias *et al.*, 2006). The study revealed a 'leaky educational pipeline', whereby at each stage of decision making, from GCSE through to post-graduate study, ethnic minority chemistry and physics students were lost to alternative subjects and career areas.

The main aim of this study was to investigate the factors affecting the decisions of under-represented ethnic groups to study physics and/or chemistry at A-level and/or university. The under-represented groups considered were British nationals from black African, black Caribbean, Bangladeshi, Pakistani, Chinese and Indian backgrounds. The research aimed to discover any differences in findings between ethnic groups, A-level and undergraduate students, between students of physics and chemistry, as well as differences relating to gender.

Methodology

The methodology of this small-scale qualitative study had two strands:

- **Strand 1:** Up to 24 focus groups with A-level students. Each focus group was composed of students from a single ethnic minority group and a single gender. This would be supplemented with individual interviews where appropriate
- **Strand 2:** Individual telephone interviews with up to 24 chemistry and physics undergraduates, including those with an interest in postgraduate study.

Sample

The sample for the research comprised 125 individuals studying physics and/or chemistry, 22 of whom were undergraduates and 103 of whom were A-level students. The sample included individuals from across all the ethnic groups targeted in the study, but some were under-represented, most notably black Caribbean young people (see chapter two for more details).

About choices and influences

There was a clear hierarchy of influences acting on decisions to study physics and chemistry. 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**.

These influences reflect those found in the research on the young people population as a whole (Morris, 2006). Young people's subject choices are reported to be affected by their interest in and enjoyment of the subject, its potential role in their future career, their perceived ability in the subject, and importantly, their awareness, or indeed lack of awareness of other options. This latter point would seem particularly important for ethnic groups, given that families do not necessarily see clear routes into chemistry or physics related careers for their children (see section on family influences). Their lack of awareness of the options available is an important finding.

In this study, there were differences in the level of influence of different factors across the different categories of interviewees:

- Certain factors were more influential for some ethnic groups than others e.g. the perceptions of careers with a physics and chemistry degree, which mostly influenced young people away from physics and chemistry (see chapter 3 for more details)

- Females were more likely than males to be influenced to choose physics and chemistry by their enjoyment of the subjects, and to be influenced to drop them by their perceived difficulty
- Those studying chemistry at A-level were more likely than those studying physics to see their study of the subject as a stepping stone to a career outside the subject (e.g. medicine)
- Undergraduates were more likely than A-level students to have positive views of careers available with a physics and chemistry degree, the relevance of physics and chemistry to life, as well as scientists and the work they do. (Note that in general, young people studying physics at HE (in 2006) were more likely than their peers studying other subjects to cite their perceived high ability as a key influencing factor in their study choice, Hobsons Group, 2006).

Family influences

The research demonstrated that although in the eyes of young people, their families are not one of the main influences on their decisions to study physics or chemistry (e.g. less influential than enjoyment, or perceptions of careers), they do have an influence. For a large proportion of interviewees, their families are encouraging them towards certain subjects and careers. Whilst families are often happy for their children to study chemistry and physics at A-level, most encourage them away from studying physics and chemistry at university in favour of more vocational options (e.g. medicine, dentistry).

Existing research from the young people population as a whole reflects much of these findings. From interviews with 150 young people about their chemistry-related plans, the influence of parents ranked in seventh place out of ten identified positive influences on young people's subject and career choices (Lord *et al.*, 2007). Young people's own plans, their enjoyment of chemistry and their perceived ability in the subject ranked in the top three places in that study. It is important to note that in terms of negative influence, just two out of the 150 young people in that study actually stated that their families were actively against them pursuing chemistry-related study or careers. This links with findings from this research on ethnic groups (see p. iv). However, despite the importance placed on science by parents (and indeed the public more widely, see Research Councils UK, 2008), pupils' interest in science appears to wane during key stage 4. 'This may mean parental influence is limited in the face of experience' (Morris, 2006).

Importantly, it has been shown that parents' views of science are affected by their own experience of studying science at school (Reiss, 2001). Interestingly, findings from a recent survey of public attitudes towards science (Research Councils UK, 2008) found that Asian and particularly Black respondents were more likely than White respondents to describe their secondary science education as 'a lot' or 'a little' better than other subjects. Given this positive attitude, it is likely that there is untapped potential in the family as important encourager or influencer for young people. As pointed out below, it will be important to ensure that parents are aware of the full range of careers available to chemistry and physics graduates.

In this study, in some instances, there were differences in the extent and nature of family influence across the different categories of interviewees:

- The influence of families was stronger for Bangladeshi interviewees than other groups, and weaker for Chinese interviewees
- Pakistani and Indian interviewees were more likely than other groups to be influenced away from physics and chemistry careers through the influence of significant proportions of their families who were in certain non-related professions (e.g. medicine, pharmacy)
- Some black Caribbean and black African interviewees were told by their families that they had to work twice as hard as other groups in order to overcome disadvantage
- Indian interviewees were more likely than other groups to be influenced by their families towards certain careers (e.g. medicine, dentistry, pharmacy) as they were seen as more 'socially acceptable'
- Those studying physics were less likely to have parents that encouraged them towards specific careers/subjects, than those studying chemistry.

Overall, families differ in the extent to which they try to influence, or even restrict, their children's choices, but there are clear themes that emerge. Families are keen to see their children progress directly into a well respected career from education. Careers in physics and chemistry are not seen by families as such careers and this is attributable to:

- a lack of familial knowledge of careers available that follow from a physics or chemistry degree
- a familial perception that physics and chemistry study would not lead directly into a job in the same way that other degrees (e.g. medicine, dentistry) would, and that there is a chance of not finding a job.

Despite this, other research does show that for some ethnic groups (Asian in particular), people do feel that science is a good career choice for young people (Research Councils UK, 2008). With such positive public attitudes towards science careers, it would seem crucial to raise the profile of chemistry and physics related career paths amongst parents and young people, particularly within the Asian population.

It is important to note that families are not against physics and chemistry study *per se*. Physics and chemistry are both seen as respectable and useful subjects to study at school. The issue for families, and the young people, is not the subjects themselves, but the fact that most cannot see clear routes into specific careers from chemistry and physics degrees, and so see them as too broad to be useful in starting out on a career.

Peer influences

The research findings suggest that peers have a subtle but underlying influence on young people's chemistry and physics further study and career choices. Peers provide a discourse around chemistry and physics further study and careers, where perceptions of the subjects are explored, created and perpetuated and it is within this context that decisions are made. The students ultimately make their own decisions and many factors are more influential than peers, however choices are made within a context of trends, fashions and attitudes of a particular time. The extent of peer influence appears to vary depending on personal characteristics, own ambitions and enjoyment, the stage and strength of decision-making and the pervasiveness of other influences. The strength of peer influence on decisions does not appear to be dependent on ethnic group, although there are slight variations. The data suggests that young people's decision-making is informed by that of their immediate peers, but importantly, it is also impacted upon by other 'influential figures'. Providing access to such influential figures (particularly for females) may be an important ingredient in preventing these potential scientists from leaking out of the pipeline, particularly given that most of the A-level students were not aware of any famous chemists or physicists of their time. In addition, it would seem important that ethnic and gender diversity in chemistry and physics further study and careers be visibly promoted.

In some instances, there were differences in the extent and nature of peer influence across the different categories of interviewees:

- The influence of peers was rated as being slightly stronger in comparison to other factors for Bangladeshi young people, and particularly low for Pakistani students.
- The influence of role models seemed to be particularly high for Bangladeshi and Indian young people in relation to other factors, while it is a particularly low influence for Chinese respondents.
- Peer influence appears to decline somewhat with age, though older students may still be influenced by peers as a source of information, ideas and advice, peers in careers and role models or ‘influential figures’.
- Most A-level young people were not aware of any famous chemists or physicists of their time. Undergraduates tended to be more aware of role models in the fields of chemistry and physics than the A-level students.
- 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.

Conclusion and recommendations

This research has confirmed the existence of Elias *et al.*'s (2006) ‘leaky pipeline’, and has drawn out some of the factors that influence young people from ethnic minority groups to drop out of physics and chemistry study.

Based on the findings from the research, there are several recommendations that the RSC and IOP may want to consider:

- Provide information to ethnic minority families and young people regarding the range of options available to them after physics and chemistry degrees, the quality of such career options, and the demand for such graduates by employers. This is particularly important for Bangladeshi, Indian and Pakistani young people
- Provide information to ethnic minority families and young people regarding physics-related careers
- Provide role models that demonstrate to young people that there is ethnic diversity amongst those in physics and chemistry-related careers. This is particularly important for Bangladeshi, Indian and Pakistani young people
- Focus on improving the experience of ethnic minority young people studying physics and chemistry, especially females
- Deliver interventions relating to careers with ethnic minority families and young people early in young people’s school career (i.e. from year 7), and

ensure that there are career-related interventions with ethnic minority young people in years 12 and 13.

1. About the study

1.1 Introduction

Much research has shown that, in recent years, the popularity of science subjects at A-level and consequently in higher education has declined (particularly so for chemistry and physics rather than biology) (e.g. Stagg *et al.*, 2003; Hobsons Group, 2006). The issue may be particularly endemic for ethnic minority groups. A recent report, conducted for the Royal Society of Chemistry and the Institute of Physics, investigated the representation of ethnic groups in chemistry and physics (Elias *et al.*, 2006). The study revealed a ‘leaky educational pipeline’, whereby at each stage of decision making, from GCSE through to post-graduate study, ethnic minority chemistry and physics students were lost to alternative subjects and career areas.

Young people’s attitudes towards the sciences

A recently completed large-scale review of pupils’ experiences of the curriculum, undertaken by the NFER for the Qualifications and Curriculum Authority (QCA), includes themes pertaining to careers, the sciences and subject options (see Lord and Jones, 2006). The review revealed less enthusiastic attitudes towards science in the secondary phase compared to primary, and declining enjoyment of science throughout secondary school. Consequently, decisions about continuing science after GCSE are being made when pupils’ attitudes are unfavourable. Students were also found to criticise the lack of relevance of the sciences to everyday life. A key response from young people however, is that whilst they do see some aspects of the science as being quite important, many young people feel the sciences are ‘not for me’ (e.g. Bennett and Hogarth, 2006; Jenkins and Nelson, 2005).

Young people’s subject and career choices

Other research conducted by the NFER and others has informed understandings about when young people make subject and careers-related decisions. Previous research has suggested young people require support with subject and careers decisions at earlier stages, that attitudes towards subjects and careers are affirmed often well before A-level choices and that by key stage 5 it can be too late to influence young people’s career decision-making (e.g. Lord *et al.*, 2007; Blenkinsop *et al.*, 2006; Payne, 2003).

From the findings of the above research there appears to be a diverse range of factors influencing young people's subject decision making. In research carried out for the Economic and Social Research Council (ESRC), Morris (2006) suggests that young people's subject and career decision-making is a reaction to a complex interplay of these various factors, with three overarching themes of influence on young people: structure (curriculum, learning environment, school ethos, school type and teaching styles); agency (an individual's enjoyment of the subject, perception of usefulness, etc); significant individuals and informal environments (teachers, family, peers, wider culture and local circumstances).

Young people's subject choices relating to science

A recent study conducted by the NFER on behalf of the Royal Society of Chemistry incorporated a literature review and evaluation of RSC chemistry careers materials to investigate how pupils make subject and career choices regarding science and chemistry (Lord *et al.*, 2007). The study illuminated a number of key influences on chemistry choosing: primary science experience; careers knowledge (often inadequate); negative images of chemists and chemistry; experience of the science curriculum as difficult, and lacking in practical and explorative activity; parental and peer influence; earning potential and non-specialist teaching. Young people's own views expressed in interviews also confirmed previous findings that A-level chemistry study is often considered 'a means to another end' in terms of being a requirement for entry to other careers, for instance, medicine, dentistry and veterinary science (Lord *et al.*, 2007; Morris, 2006).

Science subject choices by young people from ethnic groups

The report on the representation of ethnic minority groups in chemistry and physics for the RSC and IoP produced a complex picture of retention and attrition (Elias *et al.*, 2006). Indian and Chinese students show a strong preference for chemistry and physics A-level but are under-represented at undergraduate and postgraduate level. Black Caribbean students are under-represented in chemistry and physics at both A-level and degree level. Pakistani and Bangladeshi students are under-represented in chemistry and physics at degree level compared to their relative numbers in A-level.

At postgraduate level, ethnic minority students are less likely than their white peers to study chemistry or physics PhD's despite being more likely to go on to further study generally (but in other subject areas). At various stages of chemistry and physics study, ethnic minority groups are under-represented compared to their white peers and are lost to other subjects and career options.

The findings of Elias *et al.*'s (2006) study suggest that ethnic minority science subject-decision making may be influenced by distinctive factors to those affecting white students. For instance, the influence of the family and perceptions about job status and security may be more salient factors in ethnic minority students' subject choice. The fact that certain ethnic groups are under-represented in chemistry and physics study may be self-reinforcing and discourage minority students from further study, clearly a less prominent issue for majority white students. Wider factors associated with access to higher education might also play a role (Gorad *et al.*, 2006).

1.2 Aims of the research

The main aim of this study was to investigate the factors affecting the decisions of under-represented ethnic groups to study physics and/or chemistry at A-level and/or university. The under-represented groups considered were British nationals from black African, black Caribbean, Bangladeshi, Pakistani, Chinese and Indian backgrounds. To investigate the factors affecting their choices, the following research questions were explored:

- What is the influence of the family on ethnic minority students' subject choices, attitudes towards further study in chemistry and physics, and to careers in physics and chemistry?
- To what extent do peer groups influence the subject choices and career decisions of ethnic minority students with regard to physics and chemistry?
- Is under-representation self-reinforcing? Are young people from ethnic groups influenced by lack of non-white 'role models' in physics and chemistry? (e.g. in further study, in chemistry and physics-related careers)
- What other factors are significant in ethnic minority students' subject choices and career-related decision-making with regard to physics and chemistry?
- What is the relative weight placed upon these different factors in these young people's decision-making?

- When are the influences on subject and career choice perceived to be most powerful in young people's decision-making?
- Is there anything that the young people feel could be done such that they would choose chemistry/physics-related further study and careers? What would influence them or help them to stay in the 'pipeline'?

The research aimed to discover any differences in findings between ethnic groups, A-level and undergraduate students, between students of physics and chemistry, as well as differences relating to gender.

1.3 Methodology

The methodology of this small-scale qualitative study had two strands:

- **Strand 1:** Up to 24 focus groups with A-level students. Each focus group was composed of students from a single ethnic minority group and a single gender.
- **Strand 2:** Individual telephone interviews with up to 24 chemistry and physics undergraduates, including those with an interest in postgraduate study.

Strand 1: A-level students

Focus groups were selected as the approach that was most likely to identify the key perceptions of the relevant ethnic groups and to access any influences that might predominate in specific ethnic groups. Individual-level data was also collected via initial proforma, and individual activity during the focus group. This allowed the use of individual stories to illustrate group data where appropriate in analysis and reporting.

Schools that had high proportions of ethnic minority pupils were targeted for the research. Participating schools were asked to distribute a short proforma to chemistry and/or physics students in years 12 and 13. These proformas contained enough information about the individual to allow the research team to identify and select a sample to participate in the focus groups. It also allowed young people to give active informed consent for their involvement, and the opportunity to identify their own ethnic background, in order to avoid any possible stereotyping. Pupils were offered a £10 HMV voucher as an incentive to participate.

Strand 2: Undergraduates

Individual interviews were selected as an appropriate approach here, rather than group research. This was due to sparser target populations, less structured means of proforma returns (i.e. identifying the students), and less structured means of meeting with students (i.e. who will host, where, when). Individual interviews afforded an opportunity to gain valuable individual contexts – not just influences, but how did they get there, and what are they going on to next?

Participants were recruited through Chemistry and Physics departments in Higher Education Institutions that have high proportions of ethnic minority students. As in the selection of A-level students, participating institutions were asked to distribute a short email proforma to undergraduate chemistry and/or physics students. This again contained enough information about the individual to enable the research team to identify and select a sample, as well as allowing students to give active informed consent for participation, and to self-identify their ethnicity. Students were offered a £10 HMV voucher as an incentive to participate.

1.4 Report structure

There are six further chapters in this report:

- Chapter 2 details the sample for the research and how it was achieved
- Chapter 3 discusses all the factors that influenced decisions about physics/chemistry study
- Chapter 4 details the influence of families on decisions to study physics/chemistry
- Chapter 5 details the influence of peers and role models on decisions to study physics/chemistry
- Chapter 6 summarises the findings of the research in relation to each of the six ethnic groups
- Chapter 7 concludes the report by drawing together the key findings and messages.

2. About the sample

2.1 Introduction

The research design laid out a sample of:

- **24 focus groups with A-level pupils:** This included two focus groups of males and two focus groups of females from each of the six under-represented groups. Each group contained between four and five pupils, and the aim was to sample equal numbers of students studying physics and chemistry.
- **24 interviews with undergraduates:** This included four individuals from each of the six under-represented groups, including at least one male and one female. The aim was to get equal numbers of chemists and physicists.

The achieved sample for the research overall is contained in Table 1 below, and the sample for each strand is discussed in more detail later. From the overall sample it can be seen that:

- Some ethnic groups were under-represented in the sample, most notably black Caribbean students, due to the small numbers of such students studying physics and chemistry at A-level
- There was an even balance between males and females
- Despite the relatively larger number of participants studying chemistry compared to physics, over a third of participants (38 per cent) were studying physics. The lesser proportion reflects the difficulty of accessing physics students, especially at school (e.g. more schools that were contacted taught chemistry than physics and therefore a few schools in the final sample did not teach physics).

Table 1: Total sample

Ethnic group	Total	Male	Female	Chemistry	Physics	Physics and Chemistry
Black African	25	13	12	19	3	3
Black Caribbean	8	2	6	6	2	0
Indian	36	18	18	16	9	11
Pakistani	24	11	13	21	3	0
Bangladeshi	15	10	5	6	3	6
Chinese	17	9	8	9	6	2
Total	125	63	62	77	26	22

2.2 A-level sample

The original intention was to carry out the 24 focus groups in six schools. However, it became clear that individual schools did not have the numbers of pupils from the under-represented groups studying physics and chemistry that were originally envisaged. Therefore it was decided that in order to meet the target:

- A larger sample of schools would need to be drawn, and more schools contacted and visited
- Some individual interviews would need to be carried out in order to boost the sample, as students were more widely dispersed than originally anticipated, and therefore it was not always possible to form focus groups.

In order to achieve the sample, the research team contacted a sample of **66** schools/sixth form colleges which had high proportions of ethnic minority pupils. Of these, **18** agreed to participate in the research. Initial discussions with the research team suggested that some of their pupils fitted the sample, and so the teachers were given proformas to distribute to their A-level physics and/or chemistry students. The research team then chose schools to participate based on the numbers of pupils fitting the sample, and whether the pupils consented to participate. In all, **11** schools participated in the research.

The 11 schools were spread across five of the nine Government Office Regions (see table 2 below), and included a mix of secondary schools, sixth form colleges, and FE colleges (see table 3 below). The majority of the participating institutions were co-educational, apart from one all-boys school and two all-girls schools.

Table 2: Location of participating schools

Government Office Region	Schools in sample
East Midlands	1
London	3
South East	1
West Midlands	4
Yorkshire and Humber	2
	11

Table 3: Type of schools that participated

Type of school	Schools in sample
Community	3
Foundation	2
Independent	1
Sixth Form College	4
FE College	1
	11

Schools were selected where there was the possibility of several focus groups, and individual interviews were carried out at those schools where there were individuals from ethnic groups that were under-represented in the sample. Ultimately, the majority of data came from focus groups, with **17 groups** involving **80 pupils**. Additional to this, there were **23 individual interviews**. The sample of A-level students is detailed in table 4 below.

Table 4: A-level sample

Ethnic group	Total	Male	Female	Yr 12	Yr 13	Chemistry	Physics	Physics and Chemistry
Black African	22	11	11	4	18	17	2	3
Black Caribbean	6	2	4	3	3	4	2	0
Indian	30	15	15	14	16	12	7	11
Pakistani	19	8	11	9	10	18	1	0
Bangladeshi	13	9	4	11	2	4	3	6
Chinese	13	7	6	6	7	9	2	2
Total	103	52	51	47	56	64	17	22

2.3 Undergraduate sample

The original intention was to carry out 24 interviews over the telephone with students from three or four universities. Originally, seven chemistry and eight physics departments were contacted that were known to have high proportions of students from ethnic minority groups. However, as with the schools, fewer eligible students applied from the institutions than were originally expected and therefore a larger sample was needed. In order to achieve the sample, every chemistry and physics department in England, Scotland and Wales was contacted to see if they would pass on an email request to their students to be involved in the research. Following this, **28 chemistry departments** and **30**

physics departments agreed to participate by passing on our email to students.

The research team received **595 proformas** from students, from which the sample was selected. All eligible students (i.e. British national from one of the six ethnic groups) who returned a proforma were contacted for interview unless the sample for that group had been achieved. In practice, only a handful of Indian students did not need to be interviewed for this reason. Although the returned proforma count appears high, the vast majority of respondents were ineligible for the research due to ethnicity and/or nationality (i.e. white, or other ethnic group not fitting the criteria).

The achieved sample is described below in table 5. These students were spread across different stages of a degree with seven first-year, six second-year, seven third-year and two fourth-year students, and included students considering or planning postgraduate studies in physics or chemistry.

Table 5: Undergraduate sample

Ethnic group	Total	Male	Female	Chemistry	Physics
Black African	3	2	1	2	1
Black Caribbean	2	0	2	2	0
Indian	6	3	3	4	2
Pakistani	5	3	2	3	2
Bangladeshi	2	1	1	2	0
Chinese	4	2	2	0	4
Total	22	11	11	13	9

2.4 Parental occupations of sample

Both the A-level and undergraduate students were asked to indicate the occupations of their parents in the initial proformas sent out to identify a sample. The majority provided this information, which was then classified into occupational groups using the National Statistics Socio-Economic Classification (NS-SEC) using the simplified method (ONS, 2005). The breakdown of occupations can be seen in Table 6 below. The data is presented for individual parents, as well as for the highest occupational group represented in a household.

Overall, the data suggests that there were a wide range of parental occupations spanning both high skilled occupations (e.g. doctors, accountants), and lower skilled occupations (e.g. shop assistant, factory worker). The parental occupations of those undertaking A-levels were compared with those of undergraduates, and no significant differences were found either overall, or within ethnic groups. It was not the case that parents of undergraduates tended to be in higher skilled occupations than parents of the A-level students.

However, there were differences in parental occupation profiles between the different ethnic groups. The range of parental occupations within each ethnic group is detailed below:

- **Bangladeshi:** The majority of parents for whom there was information were either not employed, or employed in lower skilled jobs
- **Black African:** The majority of parents for whom there was information were working in higher occupational groups (e.g. engineer, barrister), although there was a significant minority in lower skilled occupations (e.g. shop assistant). Where there was more than one parent, both tended to be employed.
- **Black Caribbean:** The majority of parents for whom there was information were working in higher occupational groups (e.g. biomedical scientist, accountant), although there was a minority in lower skilled occupations (e.g. shop assistant). Where there was more than one parent, both tended to be employed.
- **Chinese:** The majority of parents for whom there was information were working in higher occupational groups (e.g. banker, academic, doctor), although there was a minority in lower skilled occupations (e.g. tour guide, secretary). Around half of households only had one parent who was employed.
- **Indian:** The occupations of parents for whom there was information were mixed, with just under half being employed in higher occupations (e.g. doctor, pharmacist), and the rest being employed in intermediate (e.g. shop owner) or lower skilled occupations (e.g. factory worker). Just under a half of households only had one parent who was employed.
- **Pakistani:** The occupations of parents for whom there was information were mixed, with parents most commonly being employed in higher occupations (e.g. doctor, engineer), or running their own small business (e.g. shop owner, restaurant owner). Most households only had one parent who was employed.

Table 6: Parental occupations of sample

Occupational group	Bangladeshi		Black African		Black Caribbean		Chinese		Indian		Pakistani	
	Parents	Highest H'hold	Parents	Highest H'hold	Parents	Highest H'hold	Parents	Highest H'hold	Parents	Highest H'hold	Parents	Highest H'hold
Higher managerial and professional occupations: Large employers and higher managerial occupations (e.g. CEO, director)	0	0	0	0	0	0	1	1	1	1	0	0
Higher managerial and professional occupations: Higher professional occupations (e.g. doctor, engineer, lawyer)	0	0	6	6	4	3	8	6	24	18	6	6
Lower managerial and professional occupations (e.g. teacher, midwife, civil servant)	1	1	8	4	5	3	6	3	6	4	3	1
Intermediate occupations (e.g. administrator, policeman)	0	0	1	1	2	1	2	1	3	0	0	0
Small employers and own account workers (e.g. shop owner, restaurant owner)	1	1	0	0	0	0	0	0	6	4	7	5
Lower supervisory and technical occupations (e.g. mechanic, baker)	0	0	1	0	0	0	0	0	1	1	2	2
Semi-routine occupations (e.g. factory worker, sales assistant)	1	1	4	3	2	0	4	3	11	6	0	0
Routine occupations (e.g. cleaner, bus driver)	1	1	0	0	0	0	1	1	0	0	2	1
Unemployed	9	6	2	1	1	1	1	0	4	0	4	2
Housewife	6	2	0	0	0	0	6	0	11	0	12	0
Retired	3	1	1	0	0	0	3	1	0	0	2	3
Student	0	0	2	1	0	0	0	0	0	0	0	0
No information (assumes 2 parents/guardians)	8	2	25	9	2	0	3	1	5	2	10	4
Total	30	15	50	25	16	8	34	17	72	36	48	24

3. About choices and influences

This research, although focusing in the main on the influence of family and peers on choices to study physics and chemistry, also investigated other influences that affect such decisions. This served to contextualise the influence of family and peers within all the influences on young people's decisions, and to highlight those factors that young people see as the most influential in their decision-making processes. This chapter discusses all the influences, and the relative importance of families and peers, covering:

- Overview of factors influencing subject choice in physics and chemistry
- How the factors operate
- When decisions are made.

3.1 Overview of factors affecting subject choice in physics and chemistry

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**.

This is not to suggest that low influence factors had no influence on decisions. The research suggested that all the factors had some influence on decisions, but that there were some factors that had a greater influence in the eyes of young people than others.

These influences reflect those found in the research on the young people population as a whole (Morris, 2006). Young people's subject choices are reported to be affected by their interest in and enjoyment of the subject, its potential role in their future career, their perceived ability in the subject, and

importantly, their awareness, or indeed lack of awareness of other options. This latter point would seem particularly important for the ethnic groups in this study, given the findings from this study that families do not necessarily see clear routes into chemistry or physics related careers for their children (see Chapter 4 on family influences). Their lack of awareness of the options available is an important finding.

3.2 How the factors operate

This section briefly examines each factor in turn, starting with the factor that young people rated as the most important, and concluding with the factor rated least important.

Enjoyment of physics and chemistry

Enjoyment was one of the most important influences on decisions across all the ethnic groups, and appeared to be a slightly greater influence for females than males. If they enjoyed physics or chemistry, young people were influenced to continue studying it, and if they did not enjoy it, they were influenced to drop the subject. 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). Other young people suggested that enjoyment was crucial if you continued to study a subject to a higher level, as the work got more difficult, and you spent more time on that subject as the number of other subjects you were studying decreased. This was borne out by the fact that all but one undergraduate saw enjoyment as a major influence on their decision to study physics or chemistry.

Many A-level students explained that they enjoyed physics and chemistry, but were not continuing with them at degree level. There were several reasons given for this:

- Some students wanted to pursue a more vocational degree (e.g. medicine)
- Some said that they would be using their chemistry/physics skills in their degree and would continue to enjoy the subjects as part of their degree
- Some explained that a pure physics or chemistry degree would be too narrow in scope to keep them interested.

Those that had continued to degree level, or were planning to, tended to be those that had a passion for the subject and wanted to continue with it.

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.

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 as:

- the majority of interviewees were not aware of the types of careers available with a chemistry or physics degree, or were only aware of a limited number (teaching, laboratory work and research)
- some interviewees felt that careers available with a physics or chemistry degree were not well paid, not that interesting and that there were few jobs
- some interviewees felt that a physics or chemistry degree would limit their options after graduation as the field they had studied was too narrow
- some interviewees, whilst recognising that there were many career options open to them with a physics or chemistry degree, felt that they wanted a more vocational degree, such as medicine, where they knew exactly what they were doing upon graduation. This was perceived to be a safer route than completing physics or chemistry degrees, and then looking for a job.

A minority of interviewees were aware that a physics or chemistry degree equipped them with skills that employers wanted, both in scientific industries and other fields (e.g. finance). For some, this had encouraged them to pursue physics or chemistry at university. Those with such 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.

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. Interviewees felt that there was no practical application of what they were learning, and so they had no real idea of how physics and chemistry are utilised in the 'real world'. There was a sense from some interviewees that they knew that there must be practical applications, but that they had not been made aware of them. Interviewees suggested that involving real life applications and scenarios (e.g. relating to global warming) in the teaching of physics and chemistry would encourage them to take the subjects further as they began to understand how they could be used. Some interviewees were aware of how chemistry and physics are fundamental to many aspects of our lives, and this influenced them to continue with the subjects. Those that had positive perceptions regarding the relevance of physics and chemistry were more likely to be undergraduates than A-level students.

The way physics and chemistry are taught

The way physics and chemistry are taught is an influence on young people's decisions to study physics and chemistry. Some interviewees felt they had been poorly taught, and some that the teaching had been good, but the main thread throughout the comments related to practical work. Interviewees enjoyed the practical aspect of physics and chemistry, and were encouraged to continue with the subjects when there was a significant practical element to their learning. For example, one interviewee preferred chemistry to physics as there was practical work to do in chemistry, whereas in physics she tended to

have to watch films of experiments rather than being able to carry them out personally.

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. Some interviewees had decided not to continue with physics or chemistry as a result of what they saw as poor, uninspiring or unhelpful teachers. However, where teachers were seen to be good, interviewees were often influenced to continue with physics and/or chemistry. A good teacher was one who made lessons interesting and presented information in a clear, understandable way, but who also was able to inspire students through being passionate about their subject: '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). Whilst the main focus of comments was on teachers at school who had influenced interviewees to study physics and chemistry, it was clear from undergraduates that their lecturers could also play a positive role in inspiring them to further study in physics or chemistry.

Images of scientists and the work they do

Young people are influenced in their decisions regarding physics and chemistry by their images of scientists and the work that they do. The majority of comments revealed negative perceptions. Some interviewees had a stereotypical view of a scientist, seeing them as 'nerdy' with 'mad hair', lab coats and glasses. Others had negative perceptions of the work of scientists, seeing it as being a dull job, alone in a laboratory and carrying out experiments all day. However, some interviewees had more positive images of scientists, often due to work experience where they had actually seen what scientists do and talked to them about it. Some interviewees also felt that in the media there were positive images of scientists, mentioning posters at school, and the Crime Scene Investigation (CSI) series of programmes on television. Such positive images, wherever they came from, influenced young people to choose physics and chemistry study. Undergraduates were more likely to have positive images of scientists and their work than A-level students.

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. The influence of families is discussed in detail in chapter four.

Difficulty of physics and chemistry

The perceived difficulty of studying physics and chemistry was also an influence on the choices of interviewees. In the view of many interviewees, both physics and chemistry were seen as difficult subjects, and this influenced interviewees not to pursue them. This appeared to be especially the case with females. There was a small number of interviewees who thought that physics and chemistry were easy subjects, and this influenced them to continue with the subjects as they felt they would do well. Some interviewees also acknowledged the difficulty of studying physics and chemistry, but saw this as a challenge to them, and were not discouraged from further study by the potential difficulty of the subject.

Findings from other research show that, in general, young people studying physics at HE (in 2006) were more likely than their peers studying other subjects to cite their perceived high ability as a key influencing factor in their study choice (Hobsons Group, 2006).

Role models

Role models were an influence on young people's decisions regarding physics and chemistry study. The influence of role models is discussed in detail in chapter five.

Careers advisors

Careers advisors, accessed in school or outside of school (e.g. Connexions) were an influence on some young people regarding their decisions to study physics and chemistry. Some young people had been influenced to continue with physics or chemistry after careers advisors had told them about future career opportunities following chemistry or physics study. Others had not seen

careers advisors, or had not felt that the information that they were given was useful to them.

Peers

Peers were an influence on young people's decisions regarding physics and chemistry study. The influence of peers is discussed in detail in chapter five.

3.3 When decisions are made

The research suggested that decisions to study subjects were taken close to the deadline for decisions. In general, interviewees described making their A-level choices towards the end of year 11, rather than having a set plan that was in place before that. Similarly, they described making firm choices about what to study at university close to the UCAS deadline. Interviewees generally suggested that in year 12 they had an idea of what they thought they might want to do at university and for a career, but that they only made firm decisions as the deadline for university applications approached. The experiences of physics and chemistry during years 12 and 13, the marks they received (especially at the end of year 12) and their enjoyment of their studies during this period all affected their final decision.

The notable exception to this general trend was the small minority of interviewees (eight individuals from all ethnic groups apart from Indian) who had made a firm decision to aim for a specific career earlier in their lives, which then determined the subjects they chose at A-level and degree. Some interviewees suggested that they had been working towards a particular career since an early age, and others said that had decided on a career during their GCSE studies. In these instances, the career was often medicine and individuals often had families that were specifically encouraging them in that direction.

3.4 Key points

It is clear that there are a number of factors that can explain why individuals are lost to physics and chemistry at major decision points. In order to keep young people engaged in physics and chemistry there would appear to be two main areas in which continued interventions would be useful:

- **Increasing awareness of the potential careers** available with a chemistry or physics degree, especially in relation to other more favoured careers (e.g. medicine, pharmacy, law etc.). As will be discussed in chapter four, this is potentially important for both young people and their families
- **Improving the experiences of young people studying physics and chemistry at school** e.g. by ensuring that there is a significant practical element to their learning, ensuring that pupils learn how chemistry and physics are applied in the ‘real world’, and helping to ensure that teachers have the resources/opportunities they need to make their lessons inspirational and enjoyable.

There were differences in the level of influence of different factors across the different categories of interviewees:

- Certain factors were more influential for some ethnic groups than others e.g. the perceptions of careers with a physics and chemistry degree, which mostly influenced young people away from physics and chemistry (see chapter 3 for more details)
- Females were more likely than males to be influenced to choose physics and chemistry by their enjoyment of the subjects, and to be influenced to drop them by their perceived difficulty
- Those studying chemistry at A-level were more likely than those studying physics to see their study of the subject as a stepping stone to a career outside the subject (e.g. medicine)
- Undergraduates were more likely than A-level students to have positive views of careers available with a physics and chemistry degree, the relevance of physics and chemistry to life, as well as scientists and the work they do.

4. Family influences

The findings from this research suggest that families do have an influence on the choice of young people to study chemistry and physics. Family is seen as a middle-ranking influence, most often ranked in the middle third of the list of 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. Chinese interviewees rated the influence of their families significantly lower than the other groups, consistently seeing family as a low-ranking influence in the bottom third of their list of influences. Bangladeshi interviewees rated the influence of their families slightly higher than other groups. This chapter discusses the influences families were perceived to have on decisions, covering:

- How family influence operates
- Families' views regarding chemistry/physics further study
- Families' views of careers available with a chemistry or physics degree
- Family aspirations due to gender
- Cultural influences.

4.1 How family influence operates

Young people were aware of the influence of their families and described how those influences had acted on them. 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)

Interviewees described discussing their choices with their families, and the data suggests that these discussions may be more likely to happen in the lead up to major choices (e.g. choosing A-levels or degree courses). However, it was clear from some of the interviewees that their parents had been actively

influencing them towards a particular field of study and/or career from much earlier in their school careers. The degree of influence that parents exerted on their children can be categorised into three levels:

- Parents encouraged their children towards **specific subjects and careers**, and actively discouraged them from other paths
- Parents encouraged their children to ensure they worked towards a **good career**, without specifying what it should be.
- Parents **supported and advised** their children without influencing them to take any particular direction.

Encouragement towards specific subjects and careers

For a significant proportion of interviewees, their families were influencing them towards choosing specific subjects and careers. Interviewees reported being encouraged to take subjects either because they were seen as being a route to a number of successful careers, or because they were necessary for the specific career the families were encouraging their children towards. The key issue for parents, in the eyes of their children, was to ensure that they worked towards a respectable, stable and safe career.

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 a good career. Families encouraged their children to study the sciences, as they were seen to be subjects that intelligent young people took, subjects that would be useful for future careers, and which had prestige attached. As one interviewee commented:

I think from a very 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)

However, this tended to be the case at A-level choice, rather than degree level. In terms of subjects at degree level, parents tended to encourage their children towards more vocational degrees, such as medicine. Some interviewees said that their families did encourage them to study pure science degrees at university as they would lead to a good career, but most families discouraged their children from this route, as families did not feel there were any direct career opportunities available with a chemistry or physics degree. Some

interviewees explained that their families felt studying chemistry or physics was too broad, and would not lead them into a specific career.

The thing is with my family and things when we go into higher education, it's usually for a degree that we can actually get a job out of straight away. So chemistry is very broad and there's no, like, one job you can get out of it. So I'm thinking I'd rather go into dentistry where I can become a dentist from it. (Pakistani female, A-level, chemistry)

Where families were encouraging their children towards certain **careers**, the most mentioned career was medicine, with dentistry, law, accounting and engineering also being mentioned. These were seen by families as prestigious careers within which an individual could earn a good income, and always be sure of having a job. 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.

In my family it's ultimately that you get a good job, a steady career, stable, where you're earning money and it's respected and stuff. (Pakistani female, A-level, chemistry)

[The prestige attached to being a chemist] *would still be high but it wouldn't be as high [e.g. as medicine] because some people wouldn't understand.* (Black African female, A-level, chemistry and physics)

My parents would have liked me to go on to medicine...They've never really known anything about chemistry. My mum and dad aren't really educated. So the chemistry is just a subject, nothing more. (Pakistani female, undergraduate, chemistry)

My parents, they don't see that many people doing chemistry, so they think that you don't get many good jobs out of it. (Pakistani male, A-level, chemistry)

They encouraged me not to do physical science, so they said it's not much of a job security – 'what you going to do with chemistry or physics? Do medicine or biology.' (Pakistani female, undergraduate, chemistry)

The encouragement of families towards certain careers was similar across all the ethnic groups involved in the research. However, those studying physics were less likely to say that their parents were encouraging them towards certain subjects and careers than those studying chemistry. Some of the small

number who did study physics and had parents who suggested that they choose certain careers and subjects, as outlined earlier, explained that they had gone against their parents wishes to go ahead with physics.

Despite the influence of families detailed above, this did not always have a deterministic effect on young peoples' decisions. A minority of young people continued with physics or chemistry study despite the discouragement of their families. In some cases the young people explained their reasons, for example regarding the careers opportunities, and convinced their parents that it was a good idea. In other cases they just went ahead with their decision independently of their parents:

... my mum she was wanting me to be a doctor, she wanted me to do medicine. Because I'm quite independent, when it came to the UCAS application, I didn't feel the need to tell them because I thought this is my career, this is my future, so it's more of my thing to do. The first time they found out I was doing physics was when I told them I'd been accepted by UCL. They were kind of surprised. (Indian male, undergraduate, physics)

Encouragement to aim for a good career

Some interviewees felt that although their families were not encouraging them towards specific courses or careers, they were encouraging them to make sure that the route they took would lead them to a 'good career'. There were three ways that this was apparent in families. Firstly, some parents made clear that they wanted their children to **'get' a degree**. Parents felt that the route to a successful career was to gain a degree, and that was more important than the actual subject in which the degree was achieved.

Getting to university has always been like the main goal, make sure you get your degree has been a mantra in the house. (Black African male, undergraduate, physics)

...it was almost like you have to go to university if I want to get somewhere in life and I had that from an early age. (Indian male, undergraduate, physics)

Regarding going to university, mum and dad have always been talking about [it] so [it] became a given. They didn't say I had to do [it], but they said we're hoping you're going to greater things. [That] influenced me to actually want to do a degree. Having a degree would make it easier to get a job that you like and help whatever I'm going to

be in life, help looking after me. (Bangladeshi male, undergraduate, chemistry)

Other interviewees were encouraged to **plan ahead** when making their subject choices and ensure that their choices would lead them to a good career, rather than just choosing what they wanted with no thought to the future. As one interviewee explained: ‘... *my parents said do what you want ... as long as you know you’re going to get a job and have good money.*’ (Pakistani female, A-level, chemistry).

Finally, some families simply encouraged their children to **aim high** in terms of their futures, and work towards being successful in a respected career.

Support and advice

Some interviewees felt that they made their own decisions around what subjects to study, and what careers to aim for, and their families supported them in those decisions. A key issue for their families was that they were studying something that they enjoyed.

Family is [a] stronger [influence] than peers, but because with my family they let me do whatever I feel happy doing, I’m quite lucky in that respect, I can do whatever I want really. (Black Caribbean female, A-level, chemistry)

For me, I know the typical stereotype is that in Asian communities parents usually urge children to go into medicine or those sorts of fields, but with my parents it’s quite different. They’ve always been very supportive of whatever I find I enjoy, so that just happens to be physics and the choices I’ve taken. So they are pretty okay with me with whatever I do, so on my part it’s been pretty much a self-informed decision. (Indian male, A-level, physics)

I’ve just wanted to do medicine and my family didn’t really mind what I did. They’ve always let me do what I want to do, that’s about it, they didn’t have much to say. (Chinese female, A-level, chemistry)

Other interviewees described talking through their choices with families in order to benefit from their life experience, and greater knowledge about further study and careers.

It’s like my parents do advise me but it’s my choice entirely what I want to do. (Pakistani female, A-level, chemistry)

...they've got more life experience than me so they know what's going to be good for me and what's not. (Pakistani female, A-level, chemistry)

There was considerable variation in the degree to which parents were able to offer informed advice, depending on their own educational and work histories. For example, some parents had little or no experience of the education system, especially HE, whereas others were qualified to a high level and had considerable relevant experience and knowledge. In some cases, where parents did not have relevant knowledge and experience, other members of the family were turned to for advice:

... my parents didn't go through the whole university system so they don't know how it works, and because of that they kind of just like let me do what I want to do. My sister who is at university now, she sort of knows how the system works. So my parents are kind of like if you need to talk about it, or you're unsure you go to your sister ... (Pakistani male, A-level, chemistry)

As well as the ways that families and parents explicitly influenced young people, some young people had also been influenced by having members of the family in certain professions (e.g. medicine, pharmacy). This was especially the case with Pakistani and Indian young people. They found out information about the professions and the required study for these professions from relatives (e.g. uncles, siblings etc.), and some had been influenced towards these professions as they saw relatives who were successful and in a good career. This encouraged them to think that it was achievable, and that they could do the same. There were very few interviewees that had such familial role models working in physics-related or chemistry-related careers.

4.2 Families' views regarding chemistry/physics further study

Interviewees were asked about their parents' views regarding studying physics and chemistry at degree and postgraduate level. In terms of **undergraduate studies**, most interviewees explained that their parents would not have any objections to them studying physics or chemistry *per se*. However, interviewees said that their parents would not know what careers were available after such a degree, and therefore would question the wisdom of taking such a degree.

My parents wouldn't be happy with that at all because to them that wouldn't be into any sort of good career like in their eyes. (Pakistani female, A-level, chemistry)

They would ask me what I would get out of it afterwards, if I could give them an answer they would be all right with it. (Bangladeshi male, A-level, physics and chemistry)

Well they'd probably ask me what kind of jobs I'd get out of it, but if I really wanted to do it and I was really into it they would probably let me, yes. (Pakistani female, A-level, chemistry)

I did ask my parents that and they said 'oh well what kind of career can you get if you do physics at university?'. They don't see much leading from that. (Indian male, A-level, physics)

Parents wouldn't know what a chemistry degree was. (Pakistani female, A-level, chemistry)

In terms of postgraduate physics and chemistry studies, the opinions of parents were similar, and they were concerned about what their children would get out of further studies in terms of a career. However, a postgraduate degree was seen as something prestigious and good to have, and therefore some parents were positive about postgraduate study:

I mentioned it to them the other day actually and they were like, 'if you think you can do it, do it, go for it', because it's a pretty respectable route to take, to become basically the best at something, something small. As long as I can go somewhere with what I'm doing and I could go far with it that's fine. (Indian male, undergraduate, chemistry)

4.3 Families' views of careers available with a chemistry or physics degree

As already noted, the main issue raised by interviewees was that their parents did not know what careers led from a chemistry or physics degree, as the following interviewee explained:

... when you think of chemistry and physics, you're not really knowing what a lot of people do in those fields, so therefore a lot of people aren't aware and then they're like 'well what could you actually do?' It doesn't come naturally to them about what careers are available. (Indian female, A-level, chemistry and physics)

Related to this was interviewees' perception that their families thought other jobs were assured as soon as you graduated (e.g. medicine, accountancy), whereas if an individual graduated and was looking for a job in chemistry or physics, they would have to search to find one. This was seen as a more risky option.

... if you go into medicine and what not you can go straight into a hospital and start training and doing rotations, whereas if you just go into physics and chemistry, you'll actually have to go and look for jobs everywhere where chemistry and physics is required and it's a bit more difficult to get into the same position. (Indian male, A-level, chemistry and physics)

A small number of interviewees reported that their parents were aware that there were lots of good careers available following a physics or chemistry degree, and that therefore they were happy for their children to follow that route. This tended to be the case when:

- young people knew themselves about career options and were able to inform their parents
- other family members worked in careers related to physics and chemistry
- parents themselves had a physics/chemistry background, or career.

4.4 Family aspirations due to gender

Across all the ethnic groups, the majority of interviewees did not feel that their families' aspirations for them were influenced by their gender. However, a minority of interviewees did feel that their parents' aspirations for them were affected by their gender, and there were several issues raised.

- **Males were under more pressure than females** to achieve, as it was seen as particularly important that they achieved a good career. One reason for this was that they were traditionally expected to be the breadwinner for their family, and to be able to look after their parents in the future.
- **Some careers were not seen as suitable for females**, as females were expected to get married, have a family, and take responsibility for running the home. Therefore jobs that were suitable were flexible, not stressful, and did not require lots of additional work. One female reported that her family had: '...said that if you have to manage your household it's a job that you can do when you get married, when you have children, something

that doesn't require you to spend loads of time overtime.' (Indian female, A-level, chemistry)

- Interviewees felt that their **families saw some subjects as inappropriate for males** (e.g. creative arts) and they were encouraged to focus on more academic subjects such as the sciences and maths
- Families wanted **females to attend universities close to home**, which limited their choices in terms of university and subjects.

4.5 Cultural influences

The majority of interviewees felt that there were cultural influences that acted through their family and influenced their choices of physics and chemistry study. This was the case across all the ethnic groups except for black Caribbean interviewees, and was especially the case for Indian and Bangladeshi interviewees.

Due to their cultural background, interviewees felt that there was **pressure to do well and continue in education**. Many interviewees explained that their parents did not have the same educational opportunities that are available to them now, and that they were keen for their children to make the most of what is on offer. Families see education as very important, and the route to a good career which will lead to a good and secure income. In some instances, interviewees suggested that there was greater pressure on males than females. Some black African and black Caribbean students also explained that their parents told them they had to work harder than others to overcome disadvantage:

... being female and black means you have to work twice as hard as everyone else, just to get anywhere and move up. So I was always told to get my grades, and work experience. So you can't be knocked down for... you haven't got the grades, you haven't got the work experience and on top of that you're female and you're black. So I have got to make sure I work twice as hard and push myself a bit further to make sure I'm not disadvantaged. (black African female, undergraduate, chemistry)

Interviewees also felt that there **certain careers that were viewed more positively** within their cultural group (e.g. medicine, dentistry, accountancy, law). As discussed earlier, such careers are seen as prestigious and secure, and can be entered directly from a vocational degree path, minimising the chances of not finding a job. Careers relating to physics and chemistry were not

generally thought to have these attributes, and therefore families did not encourage their children down such routes. Some Indian interviewees indicated that there was a ‘knock-on’ effect of this, in that they knew many people in these careers (e.g. medicine, dentistry etc.), which sometimes influenced them towards these career paths.

Indian interviewees appeared to feel this influence more strongly than other ethnic groups. One interviewee explained the cultural importance of an individual’s career,

Status, career, money, all of it comes into it, because they don’t think of a job just as something that you do, it’s something that defines you.
(Indian female, A-level, chemistry and physics)

The careers viewed more positively were described as more ‘socially acceptable’ by another Indian interviewee, and it was suggested that people in such professions had a higher status in society than others in less regarded professions. This was felt to have a positive impact if families were arranging marriages for their children.

4.6 Key points

The research demonstrates that although in the eyes of young people, their families are not one of the main influences on their decisions to study physics or chemistry (e.g. less influential than enjoyment, or perceptions of careers), they do have an influence. For a large proportion of interviewees, their families are encouraging them towards certain subjects and careers. Whilst families are often happy for their children to study chemistry and physics at A-level, most encourage them away from studying physics and chemistry at university in favour of more vocational options (e.g. medicine, dentistry).

Existing research from the young people population as a whole reflects much of these findings. From interviews with 150 young people about their chemistry-related plans, the influence of parents ranked in seventh place out of ten identified positive influences on young people’s subject and career choices (Lord *et al.*, 2007). Young people’s own plans, their enjoyment of chemistry and their perceived ability in the subject ranked in the top three places in that study. It is important to note that in terms of negative influence, just two out of the 150 young people in that study actually stated that their families were

actively against them pursuing chemistry-related study or careers. This links with findings from this research on ethnic groups. However, despite the importance placed on science by parents (and indeed the public more widely, see Research Councils UK, 2008), pupils' interest in science appears to wane during key stage 4. 'This may mean parental influence is limited in the face of experience' (Morris, 2006).

Importantly, it has been shown that parents' views of science are affected by their own experience of studying science at school (Reiss, 2001). Interestingly, findings from a recent survey of public attitudes towards science (Research Councils UK, 2008) found that Asian and particularly Black respondents were more likely than White respondents to describe their secondary science education as 'a lot' or 'a little' better than other subjects. Given this positive attitude, it is likely that there is untapped potential in the family as important encourager or influencer for young people. As pointed out below, it will be important to ensure that parents are aware of the full range of careers available to chemistry and physics graduates.

In this study, in some instances, there were differences in the extent and nature of influence of different factors across the different categories of interviewees:

- The influence of families was stronger for Bangladeshi interviewees than other groups, and weaker for Chinese interviewees
- Pakistani and Indian interviewees were more likely than other groups to be influenced away from physics and chemistry careers through the influence of significant proportions of their families who were in certain non-related professions (e.g. medicine, pharmacy)
- Some black Caribbean and black African interviewees were told by their families that they had to work twice as hard as other groups in order to overcome disadvantage
- Indian interviewees were more likely than other groups to be influenced by their families towards certain careers (e.g. medicine, dentistry, pharmacy) as they were seen as more 'socially acceptable'
- Those studying physics were less likely to have parents that encouraged them towards specific careers/subjects, than those studying chemistry.

Overall, families differ in the extent to which they try and influence, or even restrict, their children's choices, but there are clear themes that emerge. Families are keen to see their children progress directly into a well respected

career from education. Careers in physics and chemistry are not seen by families as such careers and this is attributable to:

- a lack of familial knowledge of careers available that follow from a physics or chemistry degree
- a familial perception that physics and chemistry study would not lead directly into a job in the same way that other degrees (e.g. medicine, dentistry) would, and that there is a chance of not finding a job.

Despite this, other research does show that for some ethnic groups (Asian in particular), people do feel that science is a good career choice for young people (Research Councils UK, 2008). With such positive public attitudes towards science careers, it would seem crucial to raise the profile of chemistry and physics related career paths amongst parents and young people, particularly within the Asian population.

It is important to note that families were not against physics and chemistry study *per se*. Physics and chemistry were both seen as respectable and useful subjects to study at school. The issue for families, and the young people, is not the subjects themselves, but the fact that most cannot see clear routes into specific careers from chemistry and physics degrees, and so see them as too broad to be useful in starting out on a career.

5. Peer influences

The findings from this research suggest that peers do have some influence on young people's choices to study chemistry and physics. However, in the majority of cases peers are not one of the most dominant influences on subject and career choice and it was ranked in the bottom third of possible influences and usually rated lower than family influence (outlined previously). In addition, approximately one-third of young people reported peer influence as having no influence upon their decisions. There is some evidence to suggest peer influence declines with age; based on young people's reflections as well as the finding that undergraduates are more likely than A-level students to respond that peer influence is not a factor in their chemistry and physics decision making. The data indicates that 'role models' are the strongest form of peer influence.

Although there were no strong trends emerging from the data to suggest peer influence differs considerably by ethnic group, some variations did emerge. Peer influence appears to be a particularly high influence in relation to other factors, for Bangladeshi young people and, particularly low for Pakistani students. Role models seemed to be a particularly high influence for Bangladeshi and Indian young people in relation to other factors, while it is a particularly low influence for Chinese respondents. 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. There was no evidence to suggest the strength of peer influence differs by subject (chemistry or physics).

There are a number of ways in which the respondents appeared to be influenced by peers and these are discussed in themes below. This chapter discusses the influences peers were perceived to have on chemistry and physics decisions, covering:

- How peer influence operates
- How the influence of role models operates
- How the influence of ethnic under-representation operates.

5.1 How peer influence operates

Peer influence appears to operate in a number of different ways and to different extents on young people. Peer influence can operate to have both a direct and a more subtle, indirect impact on chemistry and physics decision-making, though it is rarely presented as being one of the strongest or most determining factors.

Types of peer influence emerging from the young people's comments included:

- Peers as a source of information, ideas, advice and discussion
- Peers in careers/subjects
- Peers' views of chemistry/physics
- Peers' affective influence
- Peers 'stick together'
- Peers with similar interests and characters

These types of peer influence will now each be discussed in turn.

Peers as a source of information, ideas, advice and discussion

Respondents described how they discussed subject and career options with their peers and how, through this process, they picked up new information, ideas and opinions. Peers were a greater source of information, ideas, advice and discussion for A-level students than for undergraduate interviewees, although, for a small number of the latter this had also been an influence. Ultimately, the students recognised subject and career decisions as their own choice and seemed to sift out the relevance of information from peers, depending on other factors, such as the strength of their decision, personal characteristics and other sources of information. A selection of comments are presented below to provide a flavour of how the students described this subtle source of information and influence.

When I look at what I want to do as a career I will mention it to my friends and they'll say 'oh don't do that because of this', but I'm not going to do it because he said it, but I will take it on board and think, oh yeah, maybe that is an option, I'll research it a little bit more. (Indian, male, A-level, chemistry and physics)

We do discuss, we discuss chemistry and jobs and internships you can do over the summer and things people have applied for. (Indian, female, undergraduate, chemistry)

So your course mates do influence your career choice because they tell you how good it is and their experiences of other stuff (e.g. extra curricular activities, placements). (Chinese, male, undergraduate, physics)

I'll discuss with my friends 'oh what do you want to do' and stuff like that, but it's sort of like everyone has their own different thing. (Black Caribbean, female, A-level, chemistry)

Peers in careers/subjects

The young people conveyed how their subject and career decision-making was influenced by peers, including older students, friends, siblings and relatives, who they knew of in careers or on degree courses. These peers acted as informants, telling the young people what it was like in their job or on the course, and inspiring them with what they too could be like and achieve. Where respondents had such peers in chemistry/physics careers and subjects, this worked as both a positive and negative influence; inspiring them by showing what further study and careers were like as well as 'turning them off' if they realised it was not for them. The young people also described having peers in non-chemistry and physics careers, such as in medicine, pharmacy and dentistry, and how this had influenced them to select such options. For several of the undergraduate chemistry and physics students, having contact with peers, such as older students, PhD students and lecturers, had been a positive influence for them, reassuring and motivating them with insights of what they could achieve in the subject, and ultimately, encouraging them to stay in the pipeline. Some of the students' own words in describing this type of influence are presented below.

You see how people you know have succeeded with degrees they've done, what they've gone on to do. It helps you because they talk about it and it makes you realise what you want to go into. (Indian, female, A-level, chemistry and physics)

[Influence of sister who is a chemist] *It doesn't seem as appealing, because I think two years ago she went to Singapore to work at a company there as a chemist and she said it was really boring and she was analysing concrete and that's about all she did for like two months – she didn't have a great time so a turn-off. (Chinese, female, A-level, chemistry)*

I didn't know anything about them [degrees/careers] at all and then when I came to Year 12 just speaking around and to other people who were picking the same subjects as me and the people in Year 13, they just say you can do pharmacy or medicine. (Black African, female, A-level, chemistry)

I'm considering a career in the chemical industry more now than I was when I applied, because I felt that I wasn't sure if I would have the ability for that - and that's only within eight months of being here. Seeing what other people do, third years and second years and you can see the improvement that they've had over the course of their degree, makes you realise that you do learn something over three years and you really can do something useful. (Indian, male, undergraduate, chemistry)

Peers' views of chemistry/physics

Peers' views of chemistry and physics in terms of enjoyment, perceived difficulty and attitudes to career options were found to be a form of influence on the young people's chemistry and physics decision-making. This factor worked to both influence young people towards chemistry and physics, where peers' views were positive, and away from chemistry and physics, where peers' views were negative. 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. Young people are thus making decisions about chemistry and physics within a context of generally negative perceptions amongst young people of careers in these areas. The undergraduates' comments highlight the importance and value they place on being part of a pro-chemistry/physics culture at university. However, they also described how this had not necessarily been the case at the time they had made the decision to continue, where they had perhaps had to reject peers' unfavourable views to follow their passion. Overriding the views of peers may thus rely upon strong enjoyment and ambition to continue with chemistry and physics.

You take advice from them, like I talk to my friends, 'oh should I do this', and they would understand why you wouldn't want to do a chemistry degree. (Pakistani, female, A-level, chemistry)

People who don't do it [chemistry] think we're crazy because apparently it's really, really, really difficult. (Chinese, female, A-level, chemistry)

We've all done the degree over three years and we've all had ups and downs and it's nice to know that I'm not the only one crazy enough. It kind of gives me information that I'm not crazy in terms of going on to do a PhD because I know there will be other people's support. (Black African, male, undergraduate, chemistry)

I have people I can relate to and I think they have kind of helped to keep me going on into university and stay here as well, it makes me feel if someone is doing it at the same time as me, we're all in it together (Black Caribbean, female, undergraduate, chemistry)

I've never really met that many people who share the same passion as me. It's always something that I particularly wanted to do, not particularly knowing anybody who had gone all the way to doing physics. (Black African, male, undergraduate, physics)

Peers' affective influence

The students discussed how peers could be a source of inspiration, support, motivation and encouragement to one another to achieve their best and aim for successful futures. Peers were also felt to be a source of competition. Within this environment, students are motivated to achieve well, and do as well as their peers. In so doing, messages emerged across the groups about how particular careers were more revered than others and hence some were a greater marker of achievement. Although chemistry and physics are considered respectable subjects and careers (e.g. indicator of intelligence), they were often not deemed as the most desirable and hence, the sense of competition and motivation towards these destinations was undermined and directed towards alternative options. Young people may select subjects and careers from a limited range depending on their currency and value at that time amongst peers.

This year there are a lot of people who want to go into medicine and dentistry and so even though they are your friends you have to see them as competitors and you want to work harder than them. That influences how hard you work. (Chinese, female, A-level, chemistry)

They'll either say 'I'm doing pharmacy' or 'medicine', they would either be doing pharmacy or medicine and I just chose to do medicine. (Black African, female, A-level, chemistry)

Peers ‘stick together’

A very small number of A-level students commented that they chose to do subjects/careers because they wanted to stay with their friends and they knew others were taking that option.

Peers with similar interests/characters

Several A-level students and one undergraduate commented that their subject and career choices were influenced by the fact that they tended to befriend people with similar interests (e.g. ‘sciencey’) and of similar intellect. Accordingly, the kinds of things they wanted to do next and the options they considered, were likely to be similar.

5.2 The influence of role models

The young people in the sample were asked to discuss whether they felt they had any role models or influential figures (such as famous scientists, teachers, lecturers and others) in chemistry and physics and if so, how such role models influenced their decisions. From this discussion, it emerged that where role models existed in chemistry and physics they had considerable impact, with both A-level students and undergraduate students claiming that someone they knew or were aware of had inspired their enthusiasm for chemistry or physics. Such influential figures also included the young people’s relatives, peers, older students and family friends (and in this sense the influence of role models overlaps with the peer influence, ‘peers in careers/subjects’ discussed in section 5.1). Role models seemed to be a particularly high influence for Bangladeshi and Indian young people in relation to other factors, while it was a particularly low influence for Chinese respondents. Interestingly, several students spoke of how work experience had provided them with access to such influential figures within chemistry and physics.

Work experience in pharmacy, they’ve explained what they do and I thought that was really interesting, like making the actual medicines. You could either do it like as a manufacturer or actually in the shop or in hospital. The recent one was in a hospital, I was with some masters students and they were doing their practicals growing neurons, it was really interesting how they researched it. I was opting originally for medicine but I thought that side of the hospital was actually interesting because not everybody knows about it, everyone thinks if you work in a hospital oh you’re a doctor or nurse and it’s not, it’s oh I do the research for them to allow the procedures to work. (Indian, female, A-level, chemistry and physics)

Albert Einstein for example, I've read a lot of his philosophy, that's very interesting. I think the general thing around following science is that as well as being a subject in itself, it sort of encompasses your whole life, in that it expands your horizons a lot more and gets you thinking about stuff, about everything differently and thinking through stuff more thoroughly. (Indian, male, A-level, physics)

Famous scientists... For me it's probably Geoffrey Wilkinson, he was a famous scientist at Imperial and also he's a Nobel prize winner. You hear about them and the novel things they came up with and it wasn't so long ago - it sparks that interest within the chemistry field. (Indian, female, undergraduate, chemistry)

Despite this, a significant proportion of the A-level students also felt that there was a lack of relevant and visible chemistry and physics role models. Indeed, most A-level young people were not aware of any famous chemists or physicists of their time. A-level female students were particularly unlikely to have chemistry and physics role models in this sense and were more likely than their male peers to report a lack of role models in chemistry and physics. Undergraduates of both genders tended to be more aware of role models in the fields of chemistry and physics than the A-level students, perhaps as might be expected given their greater depth of involvement in the fields. Both male and female A-level students suggested that they were more aware of, and thus more influenced by, role models and influential figures in other, non-chemistry and non-physics areas, for instance from creative and medicine disciplines. This may be particularly the case for certain ethnic groups (e.g. Indian and Bangladeshi young people) where extended family networks may provide access to, and reinforcement regarding, the most revered career options.

Talking about medicine and dentistry, there is so many people, especially in Asian families, that you know that are either a doctor or dentist and you just talk to them and you get to know a bit about the profession as well, whereas with physics and chemistry, the only people I know who have done a chemistry course are probably [physics and chemistry teachers]. (Indian, male, A-level, chemistry and physics)

I think maybe if there were more physicists and chemists nowadays who were in the public eye, I think it would make a difference to quite a lot of people. I think at school you do physics and chemistry but you don't really see how much it's used in society. (Black Caribbean, female, A-level, physics)

5.3 How the influence of under-representation operates

The students were asked to discuss whether ethnic under-representation in chemistry and physics further study and careers was something that influenced their decisions to continue. Students seldom described ethnic representation as a major factor in their careers decision-making, with some students describing it as unimportant, and indeed several students suggesting they would seek to defy stereotypes and under representation. However, the respondents did describe the attractiveness of cultural diversity in degree courses, careers and amongst employers. Young people felt it was important to see that careers are ethnically diverse, and that if they were to enter that career they could be assured of equal opportunities and would not face cultural barriers. Several chemistry and physics undergraduate students were aware of being in a minority on their course, and although this had not put them off, they expressed how they would like to see more cultural diversity in their subject. For one student, however, the lack of ethnic diversity in chemistry and physics had affected their choice of university. Students comments suggested that it was not always clear and ‘visible’ whether or not chemistry and physics were culturally diverse subject and career areas, and compared this to areas such as medicine and health, where they felt ethnic diversity was much more evident and widely acknowledged.

It would strike me as a bit weird if there was a minority of my background. I'd be worried about what the company's ideas are and what they think about having ethnic backgrounds in their area. (Black Caribbean, female, undergraduate, chemistry)

It's good to know there's equal opportunities for everything, when you see it happening it gives you confidence that you'll get the same treatment. (Indian, female, A-level, chemistry and physics)

I would feel more comfortable if there were Chinese people there, you would always like to see somebody who has the same culture, you have more to talk about really. (Chinese, male, A-level, chemistry)

Ethnicity has no importance. For me, it's more about who the people are inside, personality, and I don't care about skin colour. (Bangladeshi, male, undergraduate, chemistry)

It's not the end of the world if there's no one of my ethnicity. (Indian, male, undergraduate, physics)

Students' subject and career choices did not appear to be strongly influenced by gender representation in subjects and career areas. Comments emerged in discussions to reveal views that chemistry may be a reasonably gender-balanced area, whereas physics (and engineering) were thought to be more male-dominated areas. Female respondents discussed the possibility that with a modern and political emphasis on equal opportunities, they could potentially progress faster and gain more credence in careers where they were under-represented and in a minority. However, the young people expressed again their preference for working in an environment with an appropriate mixture of sexes and backgrounds, and it would seem appropriate that this diversity be noticeable and highlighted wherever possible.

5.4 Key points

The data presented here suggests that peers have a subtle but underlying influence on young people's chemistry and physics further study and career choices. Peers provide a discourse around chemistry and physics further study and careers, where perceptions of the subjects are explored, created and perpetuated and it is within this context that decisions are made. The students ultimately make their own decisions and many factors are more influential than peers. However, choices are made within a context of trends, fashions and attitudes of a particular time. The extent of peer influence appears to vary depending on personal characteristics, personal ambitions and enjoyment, the stage and strength of decision-making and the pervasiveness of other influences. The strength of peer influence on decisions does not appear to be dependent on ethnic group, although there are slight variations. The data suggests that young people's decision-making is informed by that of their immediate peers, but importantly, it is also impacted upon by other 'influential figures'. Providing access to such influential figures (particularly for females) may be an important ingredient in preventing these potential scientists from leaking out of the pipeline, particularly given that most of the A-level students were not aware of any famous chemists or physicists of their time. In addition, it would seem important that ethnic and gender diversity in chemistry and physics further study and carers be visibly promoted.

In some instances, there were differences in the extent and nature of peer influence across the different categories of interviewees:

- The influence of peers was rated as being slightly stronger in comparison to other factors for Bangladeshi young people, and particularly low for Pakistani students
- The influence of role models seemed to be particularly high for Bangladeshi and Indian young people in relation to other factors, while it is a particularly low influence for Chinese respondents
- Peer influence appears to decline somewhat with age, though older students may still be influenced by peers as a source of information, ideas and advice, peers in careers and role models or ‘influential figures’
- Most A-level young people were not aware of any famous chemists or physicists of their time. Undergraduates tended to be more aware of role models in the fields of chemistry and physics than the A-level students
- A-level female students are particularly unlikely to have chemistry and physics role models and are more likely, than their male peers, to report a lack of role models in chemistry and physics.

6. Summary of findings by ethnic group

This chapter brings together and summarises the findings of the research by ethnic group. It focuses on the differences between the ethnic groups in terms of influences on their decisions to study physics and chemistry. The first six tables draw together detailed data for each ethnic group. The final table summarises all the information presented in order to allow quick comparison of the differences between the ethnic groups.

6.1 Bangladeshi

About the sample

The sample included **15** Bangladeshi students, of which there were:

- **12** A-level pupils and **two** undergraduates.
- **Ten** males and **five** females
- **Six** studying chemistry, **three** studying physics and **six** studying both subjects.

The majority of parents for whom there was information were either not employed, or employed in lower skilled jobs.

Factors affecting choices of physics and chemistry

The most important influence on decisions to study chemistry and physics across Bangladeshi interviewees was their **perceptions of careers** with a physics or chemistry degree. Other important influences were their **future ambitions** and their **enjoyment** of physics and/or chemistry.

The influence of the family

Family influence operated in a similar way on Bangladeshi interviewees as on other ethnic groups in the study. However, for Bangladeshi interviewees, **family was a greater influence** on their decisions to study physics and chemistry than it was for the other ethnic groups.

The influence of peers and role models

The influence of peers operated in a similar way and to a similar extent on Bangladeshi interviewees as on other ethnic groups in the study. However, for

Bangladeshi interviewees, **role models were a slightly greater influence** on their decisions to study physics and chemistry than they were for other groups.

6.2 Black African

About the sample

The sample included **25** black African students, of which there were:

- **22** A-level pupils and **three** undergraduates.
- **13** males and **12** females
- **19** studying chemistry, **three** studying physics and **three** studying both subjects.

The majority of parents for whom there was information were working in higher occupational groups (e.g. engineer, barrister), although there was a significant minority in lower skilled occupations (e.g. shop assistant). Where there was more than one parent, both tended to be employed.

Factors affecting choices of physics and chemistry

The most important influence on decisions to study chemistry and physics across black African interviewees was their **enjoyment** of physics and chemistry. Other important influences were their **future ambitions**, the perceived **relevance** of physics and/or chemistry study to life, and their **perceptions of careers** with a physics or chemistry degree.

The influence of the family

Family influence operated in a similar way and to a similar extent on black African interviewees as on other ethnic groups in the study. However, a notable element of family influence, distinct to some black African and black Caribbean interviewees, was that their families told them they must **work twice as hard** as other groups in society due to discrimination.

The influence of peers and role models

The influence of peers and role models operated in a similar way and to a similar extent on black African interviewees as on other ethnic groups in the study.

6.3 Black Caribbean

About the sample

The sample included **eight** black Caribbean students, of which there were:

- **Six** A-level pupils and **two** undergraduates.
- **Two** males and **six** females
- **Six** studying chemistry and **two** studying physics.

The majority of parents for whom there was information were working in higher occupational groups (e.g. biomedical scientist, accountant), although there was a minority in lower skilled occupations (e.g. shop assistant). Where there was more than one parent, both tended to be employed.

Factors affecting choices of physics and chemistry

The most important influence on decisions to study chemistry and physics across black Caribbean interviewees was their **enjoyment** of physics and chemistry. The other important influence for this group of interviewees was their **future ambitions**.

The influence of the family

Family influence operated in a similar way and to a similar extent on black Caribbean interviewees as on other ethnic groups in the study. However, a notable element of family influence, distinct to some black Caribbean and black African interviewees, was that their families told them they must **work twice as hard** as other groups in society due to discrimination.

The influence of peers and role models

The influence of peers and role models operated in a similar way and to a similar extent on black Caribbean interviewees as on other ethnic groups in the study.

6.4 Chinese

About the sample

The sample included **17** Chinese students, of which there were:

- **13** A-level pupils and **four** undergraduates.
- **Nine** males and **eight** females
- **Nine** studying chemistry, **six** studying physics and **two** studying both subjects.

The majority of parents for whom there was information were working in higher occupational groups (e.g. banker, academic, doctor), although there was a minority in lower skilled occupations (e.g. tour guide, secretary). Around half of households only had one parent who was employed.

Factors affecting choices of physics and chemistry

The most important influence on decisions to study chemistry and physics across Chinese interviewees was their **enjoyment** of physics and chemistry. Other important influences were their **future ambitions**, the **relevance** of chemistry and/or physics study to life, and the influence of their chemistry and/or physics **teachers**.

The influence of the family

Family influence operated in a similar way on Chinese interviewees as on other ethnic groups in the study. However, for Chinese interviewees, **family was a lesser influence** on their decisions to study physics and chemistry than it was for the other ethnic groups.

The influence of peers and role models

The influence of peers operated in a similar way and to a similar extent on Chinese interviewees as on other ethnic groups in the study. However, for Chinese interviewees, **role models were a lesser influence** on their decisions to study physics and chemistry than for other groups.

6.5 Indian

About the sample

The sample included **36** Indian students, of which there were:

- **30** A-level pupils and **six** undergraduates.
- **18** males and **18** females
- **16** studying chemistry, **nine** studying physics and **11** studying both subjects.

The occupations of parents for whom there was information were mixed, with just under half being employed in higher occupations (e.g. doctor, pharmacist), and the rest being employed in intermediate (e.g. shop owner) or lower skilled occupations (e.g. factory worker). Just under a half of households only had one parent who was employed.

Factors affecting choices of physics and chemistry

The most important influence on decisions to study chemistry and physics across Indian interviewees was their **enjoyment** of physics and chemistry. Other important influences were their **future ambitions** and their **perceptions of careers** with a physics or chemistry degree.

The influence of the family

Family influence operated in a similar way and to a similar extent on Indian interviewees as on other ethnic groups in the study. However, it was notable that Indian interviewees thought a particularly strong influence from their families was that **certain careers were viewed particularly positively** (e.g. medicine, law), and they were encouraged towards such careers. Another familial influence on Indian interviewees related to the fact that **many members of their families were in such careers**, which further encouraged some to follow the same route.

The influence of peers and role models

The influence of peers operated in a similar way and to a similar extent on Indian interviewees as on other ethnic groups in the study. However, Indian interviewees indicated that **role models were a greater influence** on their

decisions to study physics and chemistry than for other groups. It must be noted that these role models were mostly in careers such as medicine and seldom in physics and chemistry.

.6 Pakistani

About the sample

The sample included **24** Pakistani students, of which there were:

- **19** A-level pupils and **five** undergraduates.
- **11** males and **13** females
- **21** studying chemistry and **three** studying physics.

The occupations of parents for whom there was information were mixed, with parents most commonly being employed in higher occupations (e.g. doctor, engineer), or running their own small business (e.g. shop owner, restaurant owner). Most households only had one parent who was employed.

Factors affecting choices of physics and chemistry

The most important influences on decisions to study chemistry and physics across Pakistani interviewees were their **perceptions of careers** with a physics or chemistry degree, their **enjoyment** of physics and chemistry, and their **future ambitions**. Another important influence was their **family**.

The influence of the family

Family influence operated in a similar way on Pakistani interviewees as on other ethnic groups in the study. However, for Pakistani interviewees, **family was a greater influence** on their decisions to study physics and chemistry than it was for the other ethnic groups. A particular influence on Pakistani interviewees, similar to Indian interviewees, was that **many members of their families were working in certain respected professions** such as medicine and pharmacy. This influenced some towards those careers.

The influence of peers and role models

The influence of role models operated in a similar way and to a similar extent on Pakistani interviewees as on other ethnic groups in the study. However, for Pakistani interviewees **peers were a lesser influence** on their decisions to study physics and chemistry than for other groups.

.7 Summary table

	Bangladeshi	Black African	Black Caribbean	Chinese	Indian	Pakistani
Most important factors affecting physics and chemistry choices	Perceptions of careers Future ambitions Enjoyment	Enjoyment Future ambitions Relevance of subject Perceptions of careers	Enjoyment Future ambitions	Enjoyment Future ambitions Relevance of subject Teachers	Enjoyment Future ambitions Perceptions of careers	Perceptions of careers Enjoyment Future ambitions Family
Influence of family	Greater influence than for other groups generally	Similar influence to other groups generally Families told them they must work twice as hard as others to overcome discrimination	Similar influence to other groups generally Families told them they must work twice as hard as others to overcome discrimination	Lesser influence than for other groups generally	Similar influence to other groups generally Certain careers viewed particularly positively by families, and many members of families were in such careers	Greater influence than for other groups generally Many family members worked in certain respected professions (e.g. medicine)
Influence of peers	Role models a slightly greater influence than for other groups generally Peer influence similar to other groups generally	Role model influence similar to other groups generally Peer influence similar to other groups generally	Role model influence similar to other groups generally Peer influence similar to other groups generally	Role models a lesser influence than for other groups generally Peer influence similar to other groups generally	Role models were a greater influence than for other groups generally (but mostly in careers unrelated to physics and chemistry) Peer influence similar to other groups generally	Role model influence similar to other groups generally Peers a lesser influence than for other groups generally
Sample	15 individuals (two focus groups, six interviews)	25 individuals (three focus groups, eight interviews)	8 individuals (eight interviews)	17 individuals (two focus groups, nine interviews)	36 individuals (five focus groups, eight interviews)	24 individuals (five focus groups, six interviews)

7. Conclusion and recommendations

7.1 Conclusion

As noted in the introduction to this report, previous research (Elias *et al.*, 2006) has described a ‘leaky pipeline’ whereby at each stage of decision making, from GCSE through to post-graduate study, ethnic minority chemistry and physics students were lost to alternative subjects and career areas. This research has confirmed the existence of the ‘leaky pipeline’, and has drawn out some of the factors that influence young people from ethnic minority groups to drop out of physics and chemistry study. Whilst the main issues reported by young people are consistent across all the groups, there were some differences in the nature and extent of the different factors influencing the different ethnic groups:

- The influence of **families** was **greater for Bangladeshi and Pakistani** interviewees and **lower for Chinese** interviewees than the rest of the ethnic groups
- The influence of **peers** was **lower for Pakistani** interviewees than the rest of the ethnic groups
- The influence of **role models** was **greater for Bangladeshi and Indian** interviewees and **lesser for Chinese** interviewees than the rest of the ethnic groups
- Some **black African** and **black Caribbean** interviewees were told by their families that they have to work **twice as hard** as other groups to overcome disadvantage
- **Indian** interviewees thought a particularly strong influence from their families was that **certain careers were viewed particularly positively** (e.g. medicine, law), and they were encouraged towards such careers
- A particular influence on **Pakistani** and **Indian** interviewees was that **many members of their families were working in certain respected professions** such as medicine and pharmacy.

Families

Families, although not one of the most influential factors affecting decisions to study physics and chemistry, did have an influence on young people’s choices. Most commonly in the eyes of young people, this was an influence away from physics and chemistry towards other careers (e.g. medicine, dentistry, law, accounting) that are seen to be prestigious, safe, and bringing a good income. Families did not encourage young people towards chemistry and physics

degrees as they were either not sure of what career possibilities followed such a degree, or they had negative perceptions of the possible careers in relation to other careers (e.g. vocational degree such as medicine seen to guarantee a job, alongside a perception that a physics/chemistry graduate would have to search hard to find a job).

Young people felt that their families saw physics and chemistry as respectable and useful subjects to study at GCSE and A-level, and many young people explained that their parents had encouraged them to study the sciences at school. The issue for families was not physics and chemistry *per se*, but the perception of families regarding careers available after a physics or chemistry degree. This finding suggests that if families and young people were aware of the range of career options available to them, the quality of such options (e.g. in terms of income, professional status, stability etc.) and the fact that employers are keen to recruit science graduates, then this could influence them to consider a physics and chemistry degree.

There was some evidence that chemistry was regarded differently to physics, with chemistry at A-level being more often seen by young people as a stepping stone to other careers (e.g. medicine) than physics. Those young people who had chosen to study physics were also less likely to have parents encouraging them towards certain careers and subjects. Arguably, this could point to the fact that chemistry is seen as a more useful subject by families, and so the encouragement to study chemistry is greater than that for physics. If this is the case, then there is a pressing need to provide information about physics-related careers.

Peers

Peer groups, in the eyes of young people, were less influential than families on their decisions to study physics and chemistry, and were not generally considered to be very influential. Peer groups served to provide a discourse around chemistry and physics further study and careers, where perceptions of the subjects were explored, created and perpetuated. Young people make their decisions in the context of these discourses, rather than being explicitly influenced by what their peers are choosing to do. However, this does suggest that if positive perceptions of chemistry and physics study and careers abound

in a peer group, then this would provide a context more favourable to making decisions to study physics and chemistry.

The strongest influence on young people that related to peers was role models, which had an influence on young people's decisions. However, there were few examples of role models either studying physics or chemistry, or working in related careers. Most role models described by young people were in the careers their families were encouraging them towards (e.g. medicine, dentistry), and therefore served as an influence away from physics and chemistry study after A-level. Therefore, role models in physics and chemistry could have a positive influence as part of a drive to promote awareness of careers with physics and chemistry. In general, when thinking about careers, young people were not concerned about whether their ethnic group was well represented in that field. They were more concerned about whether the workforce in an industry or company was ethnically diverse, as this suggested that there was no discrimination against ethnic minorities. Therefore, role models do not necessarily need to be specific to ethnic groups, but to represent the ethnic diversity of those in physics and chemistry-related careers.

Other factors

The most important factors influencing decisions to study physics and chemistry across all the ethnic groups were enjoyment of the subjects, personal future ambitions, and perceptions of careers available with a physics and chemistry degree. This again emphasises the importance of providing information about careers to young people and their families, as these perceptions of future careers and ambitions are likely to be influenced, at least in part, by families.

The research suggested that females were more likely than males to be influenced to continue with physics and chemistry due to their enjoyment of the subject, and more likely to drop physics and chemistry due to the perceived difficulty of the subjects. Therefore, whilst ensuring that all ethnic minority young people enjoy physics and chemistry is important, it may be especially important to consider females' experiences of physics and chemistry, ensuring that they enjoy their studies and find them manageable.

The timing of decisions

Whilst a small number of young people had decided at a young age to pursue careers such as medicine, most young people suggested that they did not make firm decisions about subject choices until the deadline for decisions. This suggests that there are opportunities for interventions to influence young people towards chemistry and physics in the lead up to GCSE options, and to the UCAS deadline. However, given that our research suggests that the major reason for drop-off relates to degree choice, and is underpinned by thinking about careers, then interventions in years 12 and 13 that relate to careers available with physics and chemistry may be most useful.

Reaching the end of the pipeline

There were some differences between undergraduates in physics and chemistry, and those studying the subjects at A-level. Whilst enjoyment was a key factor behind decisions at A-level and degree-level, there were indications that those who continued with chemistry and physics at degree level were those that had a passion for the subject and wanted to pursue it further. Of the 22 graduates involved in the research, 16 indicated that they planned to go on to chemistry/physics-related careers and/or further study, and a further four were considering chemistry/physics-related careers and/or further study alongside other options (e.g. investment banking), or had no future plans. This suggests that once young people have chosen to continue with physics and chemistry at degree level, they are likely to continue with a career related to the subject because they enjoy it.

The research also suggests that relative to A-level students, chemistry and physics undergraduates had more positive perceptions of careers in physics and chemistry, a greater understanding of the relevance of physics and chemistry, and more positive images about scientists and their work. It was not always clear to what extent these perceptions had been developed whilst at university, and to what extent they were reasons for choosing to study physics and chemistry at university. However, for some undergraduates, these factors were key to their decision to continue with physics and chemistry at undergraduate level. The families of some undergraduates supported them in their decision to study physics or chemistry at university, whilst others had tried to persuade them to study something else. Some of these undergraduates explained that it was their decision to make, and they made an independent

decision regardless of their parents' views. Others had fallen back on the subject they enjoyed the most when they had been rejected for their first choice degree (e.g. medicine), which their parents had encouraged them towards.

Overall then, key factors in reaching the end of the pipeline would appear to be a passion for physics/chemistry, and positive perceptions about the relevance of the subjects and careers related to them. This again shows the importance of providing information to ethnic minority students and their families regarding careers relating to physics and chemistry, and ensuring that their experiences of physics/chemistry study at school are enjoyable (e.g. through good teachers, practical element to learning). These are the key areas to intervene in to help ensure that more young people from ethnic minority groups remain in the physics and chemistry 'pipeline'.

7.2 Recommendations

Based on the findings from the research, there are several recommendations that the RSC and IoP may want to consider:

- Provide information to ethnic minority families and young people regarding the range of options available to them after physics and chemistry degrees, the quality of such career options, and the demand for such graduates by employers. This is particularly important for Bangladeshi, Indian and Pakistani young people
- Provide information to ethnic minority families and young people regarding physics-related careers
- Provide role models that demonstrate to young people that there is ethnic diversity amongst those in physics and chemistry-related careers. This is particularly important for Bangladeshi, Indian and Pakistani young people
- Focus on improving the experience of ethnic minority young people studying physics and chemistry, especially females
- Deliver interventions relating to careers with ethnic minority families and young people early in young people's school career (i.e. from year 7), and ensure that there are career-related interventions with ethnic minority young people in years 12 and 13.

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