INTRODUCTION TO SECTION 1

Progression from GCSE to A level physics

Aim: To explore the issues surrounding the progression of young people from the study of GCSE physics (or science) to the study of A level physics.

Contents: Report

Evaluation from the Head of Sixth Form

Evaluation from the Stimulating Physics Consultant (IOP)

Methodology: For Section 1 of this portfolio, I have explored the progression of young people from GCSE to A level physics and I have presented this in the form of a report with two evaluations.

Within this report, I have presented an overview of the national concerns with science education, using recent government reports that have highlighted the need to attract more young people to study science. In the second part of this report, I have used national statistics (JCQ) to provide a quantitative account of the number of candidates for GCSE qualifications in recent years. It was pleasing to note that the number of candidates for separate sciences at GCSE has increased over the past ten years, with a healthy proportion of female candidates. It was also good to see that the regional trend mirrored the national trends, with up to 44% of GCSE physics candidates being female. The third part of this report explores the numbers of students who are studying A level physics, both nationally and regionally, again using the JCQ website to obtain information on the national trends for A levels.

In order to provide a greater insight, and substantiate the report with qualitative methods, I contacted the Heads of Science from our partner schools and also conducted a focus group with students who had chosen to study science A levels at the college, but had not chosen to study A level physics. The students raised issues such as course content, the teachers and relevance for a future career.

Conclusions: The main findings of this study are that there many elements that contribute towards, and influence choice of subject at A level. For example:

a) The content of the course

b) The enthusiasm of the teacher (bearing in mind that many young people have never been taught by a specialist physics teacher, nor by a female physics teacher).

c) Relevance towards a future career

d) Wider influences outside of the classroom are very important, such as parents, peers, role models and the media. These latter choices must not be underestimated, and whilst not explicit, are inter-twined with social class.

Dissemination of this study: After completing this report, it was shared with the Head of Sixth Form at the FEC as well as the regional co-ordinator of the Stimulating Physics branch of the Institute of Physics. They each in turn made useful recommendations that have been added to the report. Their comments have been included after the main report in this section. The study was sent to the Institute of Physics Education Department and has been shared with my team at the FEC and with current science PCGE students.

Progression from GCSE to A level Physics

Marianne Hill

Introduction

This report will assess the progression of young people from GCSE to A level physics, both nationally and within this region. It will consider the reasons why we must increase the number of young people who study physics at A level, with girls as a very important sub-set of this group. Within the context of this study, the city shall remain anonymous and the college referred to as the FEC (Further Education College).

Part 1: This section will outline recent national reports that have been published on science education and explain why we need to increase the number of all students, both girls and boys, who study science in post-compulsory education. Along with other STEM subjects, physics develops skills that lead to a wide range of employment possibilities for young people. It is clear from the reports that the government acknowledges that there is a problem in attracting young people towards science and many recommendations have been made, yet the situation shows little signs of improvement at both national and regional levels.

Part 2: This section will discuss the trends for GCSE physics and science courses. Since the National Curriculum was introduced in 1988, it has made the study of Science compulsory for all young people up to GCSE. Over the past ten years, there has been an increase in the number of candidates for the separate GCSE science courses, along with a decrease in the number of candidates for the double award science courses. This section will consider the trends for GCSE courses and assess whether the regional data mirrors the national trend.

Part 3: This section will explore national as well as local trends for the number of students who study A level physics, with particular reference to the number of girls who choose to study the subject. From this evaluation, it can be seen that there are almost twice as many candidates who are entered for A level biology (58,000) than for physics (31,000) (JCQ, A, 2010). Physics is still a subject in which girls are under-represented, despite a wide range of initiatives and intervention strategies that have been implemented over the past thirty years. In 2010, only 21.5% of the candidates for A level physics were female (JCQ, A, 2010).

Part 4: This section will discuss some of the reasons why young people are not choosing to study physics at A level. It will include some of the findings from a small focus group of A level students who were studying chemistry but not physics. The three most important factors that emerged from the focus group were the influence of the teachers (who have taught them at school), the ‘rather dry’ content of the GCSE course and relevance towards future careers. There were also other factors such as parents, friends and careers advisors.

Part 1: Recent Reports produced on STEM subjects

There have been several reports produced in the past ten years that have highlighted the need to increase the number of students who study science, with physics as an important science subject. This section will highlight some of the main findings of these reports to contextualise the current situation with science education.

SET for Success (HM Treasury, 2002), also known as the Robert’s Review, proposed a series of recommendations that intended to increase the number of young people studying STEM related disciplines. The report identified several areas of concern, particularly the low number of female students opting for these subjects (either at A level or at university) as well as the fact that many young people have a negative image or poor experience of science. It identified other concerns such as shortages of specialist teachers, inadequate teaching environments and poor careers advice as being significant reasons why students did not select STEM subjects for their future careers.

The report stated that because there was a wide variety of employment opportunities open to STEM graduates, which offered greater financial rewards than teaching as a career, it resulted in a situation where we had a shortage of specialist teachers in STEM subjects. The report suggested that teachers of shortage subjects should be paid a higher salary than other teachers (Section 0.6). The report highlighted a need for Continuous Professional Development for science teachers and made a recommendation to introduce the new Science Learning Centres in order to promote quality science teaching throughout the country (Sections 0.19, 2.70 - 2.74).

The report discussed the various factors that influence young people with career choices, such as parents, teachers, careers advisors and even the wider influence of society. It suggested that students believe that by selecting science subjects, they are restricting their options, rather than broadening their opportunities. It recommended that specialist careers advisors could be recruited to provide greater information on the range of careers that follow from the study of STEM subjects at school (Section 0.23). Whilst conducting the research for this section, I enquired at the local Connexions Service if they had any specialist career advisors who could help students with an interest in science and they informed me that this recommendation was never implemented.

Between 1995 and 2000, the number of students who entered higher education increased by 10%, yet the number of students who were pursuing courses in science and technology decreased by 7%, and those studying maths and physical sciences fell by 1% (Section 1.8). Within science departments at universities, the growth areas appear to be bioscience and computer science courses (Section 1.8). It was interesting to note that the report claimed that maths and physics graduates were more likely to develop careers in the financial services sector, whereas graduates in biological science were more likely to work in education (Section 1.15).

The report made reference to four main factors which influence a student's achievement and enthusiasm within a particular subject:

a) The teacher, including their particular style and methods of teaching
b) The teaching environment
c) The subject curricula and extra-curricular activities
d) Other influences such as parents and the wider aspects of society

(Section 2.33)

Whilst subject knowledge and teaching style are 'vital factors', the report stated that it is the enthusiasm of the teacher that captures a pupil's interest and motivates them to study a subject (Section 2.35). The report was concerned by the fact that many schools deliver the 'double science' course and this is generally taught by one teacher, primarily for continuity, rather than specialist teachers for each science strand. This may be advantageous in that it enables the teacher to work with a particular group of young people, however, they may not have sufficient expertise to teach all of the scientific content (Section 2.53). The report stated that at key stage 4, 'nearly 30% of those teaching physics do not have a physics degree' (Section 2.55).

Teachers of shortage subjects are currently offered a 'Golden Hello', which is worth up to £4,000 as an incentive for pursuing a career in the teaching profession. It was suggested as a further incentive to attract young scientists into the teaching profession that student loans could be 'written off' after a period of up to ten years (Section 2.64).

The report highlighted the need for continuous professional development for science teachers, the importance of good facilities and environment, as well as the problems of recruiting good science technicians. It discussed aspects of the science curricula as well the importance of curriculum enhancement with external events and extra-curricular activities.

The Science and Innovation Investment Framework 2004 – 2014 (HM Treasury, 2004) outlined how the government intends science to contribute towards greater research and development, encourage economic growth, and improved public services in the UK. The report states that the government must invest towards world class scientists, engineers and technologists to develop universities, businesses and ultimately the economic growth of the UK. Chapter one outlines why ‘harnessing innovation in Britain is key to improving the country’s future wealth creation prospects’ (Section 1.1).

The second chapter of the report: ‘A vision for world class research: challenges and opportunities for the UK science base’ outlines how we must build upon our strengths to compete against other ‘emerging science nations’ to provide a skilled workforce so that the UK can be the ‘best location globally for research, development and innovation’. Further chapters discuss the management of the science base, research in universities, funding for research and how the outcomes of this research can be utilised for greater economic success for the country. The report stated that there should be greater collaboration between universities and businesses: ‘There is an economic imperative to make sure that scientific knowledge is used by business to create wealth’ (Section 5.1).

The chapter: ‘Science, Engineering and Technology Skills’ deals specifically with science education issues. The report makes reference to the *Robert’s Review* (2002): ‘The review found that fewer students in the UK were choosing to study many science and engineering disciplines’ (Section 6.2). An interesting feature in this chapter is that it suggests that the salaries of Advanced Skills Teachers in science should be deregulated so that they are paid a minimum of £40,000 per annum (Section 6.21). The report recommended that a strong programme of Continuous Professional Development for Science Teachers should be developed, along with better laboratories and school environments, and the implementation of the Science Learning Centres to provide support for science teachers:

The Government’s overall ambitions are to achieve a step change in:

- the quality of science teachers and lecturers in every school, college and university;
- the results for students studying science at GCSE level;
- the numbers choosing SET subjects in post-16 education and in higher education

- the proportion of better qualified students pursuing R&D careers

(Section 6.8)

The report outlined the government's commitment to SETNET (which is now called STEMNET) with a promised investment of £3 million per year of government support, with a further £1.8 million over three years to introduce ten regional SETNET Co-ordinators (Sections 6.30 to 6.32). Concern was expressed regarding the post-16 sector of education, observing that there has been a 13% drop in the number of students who choose to study A level maths and physics since 1995, along with a 15% drop for A level chemistry (Section 6.34). It states that this decrease has been alongside a steady growth in the number of students who are choosing A levels in business, psychology and media/TV/film studies:

> 'However, there is lack of robust national data on the recruitment and retention of SET post-16 teachers in SET. The government recognises that this is needed urgently. To further understand when and why teachers leave the sector, DfES will undertake rapid, focussed research to fill the information gaps about the SET workforce in the post 16 learning and skills sector. Early indications will be available by March 2005.'
>
> (Science and Innovation Investment Framework, 2004, Section 6.38)

This section on post-16 education was of particular concern, particularly as this is the sector of education where I am employed. At present, there are various types of institution that provide post-compulsory education, ranging from school sixth forms to colleges of further education. School sixth forms are controlled by the Local Authority, whereas colleges are operated as independent organisations. Each college (tertiary or further education) has its own management structure, staff contracts and range of subjects available. The report expressed concerns that STEM teachers were leaving this sector of education and that there was a need to determine the reasons for this situation. One of the main reasons could be due to the fact that each college operates separately and there are no national or over-arching structures for colleges at present.

The *SET for Success Report* (2002) produced responses from the government, employers and professional bodies which then led to the ***STEM Programme Report*** (DfES, 2006). This report reviewed the situation and explored whether changes had been implemented since the *SET for Success* report. One of the main features of this review was that it identified the need to develop the National Science Learning Centre as the 'British Library' of STEM professional development (Action 8). The report also identified the need to work with SETNET (Science, Technology, Engineering and Mathematics Network) to improve the co-ordination of stakeholders who contribute to the curriculum by providing opportunities for enhancement and enrichment (Action 9).

The STEM Review (Smith, 2007) was a report on how the recommendations from *SET for Success* (2002) have been implemented and explored other initiatives to develop STEM skills in graduates and postgraduates. The main conclusions included the following points:

1) Whilst the number of STEM graduates has increased since 2002, the number of students taking 'A' levels in mathematics, physics and computer sciences has decreased.
2) The 'Golden Hello' initiative was believed to have attracted more teachers for STEM subjects, but the momentum needs to be sustained and further gender and ethnic imbalances need to be addressed.
3) There has been less progress in CPD for teachers than anticipated, as well as inadequate progress in the development of school laboratories.
4) Career guidance has remained 'patchy' and that improved information for students on STEM subjects is necessary.
5) Whilst investing in university STEM departments would be costly, further closures would be inevitable if government funding is not forthcoming.

The report made a number of further recommendations including:

1) Employers and professional bodies should work to highlight the importance of STEM subjects leading to strong career prospects.

2) The weighting of STEM subjects in UCAS points.
3) Government bursaries for the study of STEM subjects.
4) Additional incentives to retain and attract STEM teachers.

The STEM Review included a section on ‘Career decisions – aspirations and options’ as careers guidance was recognised as crucial. The report made the following points:

1) Careers Advisors were sometimes limited in their understanding of STEM careers.
2) Parents are a very strong influence and whilst students may be inspired towards STEM subjects, this ‘can easily be snuffed out’ if the parents’ view is that studying science will close down options rather than opening them. It was acknowledged that parents can be very difficult to influence and need to have a greater understanding of the issues.
3) Employers - some employers are very proactive whereas others are not.
4) Connexions – it was claimed that this service provides a good focus for students who have difficulty with progression, but it has inadequate resources to help brighter students. (p.12)

Taking Stock, the CBI Education and Skills Survey (CBI, 2008), was sponsored by Edexcel and identified that the UK faces potential skills shortages for high level science skills, particularly at graduate level. The survey was conducted in November 2007 with 735 respondents, covering 1.7 million employees of the private sector workforce. The report indicated that 59% of firms that employ STEM-skilled staff are having difficulties in recruitment and that some sectors are experiencing acute shortages. Some of the larger firms have to recruit internationally, with 36% of these employers recruiting from India and 24% from China (p.26).

The CBI identified some of the main issues that must be addressed in order to increase the number of young people with STEM skills, which include good career advice, specialist teachers (particularly for the teaching of physics), up to date laboratories where ‘practical science can fire the imagination and create a passion for the subject.’ (p.29) The report also stated that CGSE Triple Award Science is the best preparation for developing STEM skills, particularly if young people wish to continue their studies to advanced level and beyond (p.29).

The Annual Innovation Report (DIUS, 2008) states that GCSEs in physics, chemistry and biology (triple science) are ‘being made more accessible to pupils who would benefit’ (p.44), however it is ambiguous whether this means that the courses are being made easier in order to boost targets or if it means that the courses are being tailored to suit the needs of the students. It could be argued that whilst efforts are always being made to make science courses interesting and appealing for young people, the new GCSEs are not necessarily providing the right foundation for ‘A’ level study of science. The report also makes reference to STEMNET, claiming that this organisation now has over 20,000 role models to inspire young people and represents over 1,000 employers (p.44). Whilst STEMNET can provide a good support network in Science, the ability to provide ambassadors or role models will depend upon the geographic region, with some areas having access to more ambassadors than others.

To summarise, part one of this report has considered several reports that have highlighted the need to increase the number of young people who study science. There have been a range of suggestions, such as shortages of specialist teachers, inadequate teaching environments and poor careers advice through to some of the wider ranging factors such as parents and society. Some of these factors are beyond the scope of this particular report, which will be confined to assessing the extent of the problem on a national and regional level. The factors that are within the scope of the practising classroom teacher will be evaluated in a separate report, and the external factors such as the influence of family and role models are to be considered in another report.

Part 2: The number of young people who study GCSE Physics

The Joint Council for Qualifications publishes national information on the numbers of pupils entered for GCSE examinations (see Table 1 for science and mathematics GCSE data).

The National Curriculum, introduced in 1988, made the study of Science compulsory for all young people up to GCSE. Since then, a range of science courses have been developed by the examination boards in order to attract and engage young people with the study of science. When the National Curriculum was implemented, it was decided that schools (in the state sector) should promote a balanced science approach, offering single, double or triple science courses, with the latter option being the three separate GCSE subjects of biology, chemistry and physics. From the JCQ data presented in Table 1, the total numbers of entrants for the separate sciences differ, with GCSE biology having 9,009 more entrants in 2010 than GCSE physics. One of the reasons could be due to the fact that independent schools do not have the same restrictions as state schools and can offer the three sciences as separate GCSE subjects. Another reason that may explain why the number of candidates for each science differs is due to the fact that schools can now offer the core science with one specialist subject at GCSE.

It is clear that more boys than girls study physics at GCSE, however girls now constitute 44.8% of the candidates (2010). Compared to the data from 2000, the number of female candidates has almost tripled in less than ten years. However, caution must be taken when analysing these figures, as the number of entrants for GCSE examination results reflect the decisions that were taken by pupils in year nine of their education, rather than the year in which the examinations were taken. What the figures do indicate is that interest in physics is increasing for pupils in the lower phase of secondary school, with healthy numbers of students selecting sciences, however the problem is that these numbers are not necessarily translating into Advanced level study.

TABLE 1: The number of young people entered for GCSE mathematics and sciences in 2000, 2009 and 2010

Subject		2000	2009	2010
Mathematics	(All)	673 056	754 738	762 79
	Girls	338 201	379 685	384 487 (50.4%)
	Boys	334 855	375 053	378 305 (49.6%)
Science	(All)	66 036	493 505	449 697
	Girls	32 679	248 823	226 957 (50.4%)
	Boys	33 357	244 682	222 740 (49.6%)
Additional Science	(All)	979 826	396 946	352 469
(Double Award in 2000)	Girls	494 446	201 411	179 359 (50.8%)
	Boys	485 380	195 535	173 359 (49.2%)
Physics	(All)	46 627	91 179	120 455
	Girls	18 338	40 327	53 933 (44.8%)
	Boys	28 289	50 852	66 522 (55.2%)
Biology	(All)	48 715	100 905	129 464
	Girls	20 904	47 494	60 416 (46.7%)
	Boys	27 811	53 411	69 048 (53.3%)
Chemistry	(All)	46 917	92 246	121 988
	Girls	19 294	41 648	55 450 (45.4%)
	Boys	27623	50 562	66 538 (54.6%)

(JCQ, GCSE, 2010)

Whilst the study of science is compulsory up to the age of 16, this is certainly ensuring that pupils receive a good scientific education, but not leading students to further study in the numbers that one would expect. This will be discussed further in the next section.

A further analysis of the JCQ data reveals that in 2010, 48.4% of all GCSE physics candidates achieved grades A* or A, and that 93.6% of candidates achieved grade C or above. The gender profile for these pass rates is very close, with less than 1% difference in the number of girls and boys achieving each grade. The pattern is similar for both biology and chemistry, with the former showing 46.9% of students achieving grades A* and A, and the latter with 48.9%. The pass rate (Grade C or above) is 92.8% for biology and 93.6% for chemistry.

The Science GCSE courses that are currently offered by the various examination boards are suitable for a range of abilities and interests. Of the three main examination boards, OCR offers the widest selection of GCSE science courses including the Gateway Suite (science, additional science, biology, chemistry and physics) and Twenty First Century Science (science, additional science, additional applied science, biology, physics and chemistry) (OCR, 2010). AQA offers GCSE science, additional science, applied science, applied additional science, biology, chemistry and physics. (AQA, 2010) Edexcel offers GCSE courses in science and additional science along with the three separate sciences (Edexcel, 2010).

For the science and additional science courses, the number of candidates for single science has shown a marked increase from 2000 to 2009, then a decrease from 2009 to 2010. The numbers of students who are studying the separate science subjects have increased from 2000 and are continuing this upward trend. It can be interpreted from these results that more schools are offering the separate (triple) science GCSEs, whereas in previous years, pupils have been encouraged to study the double science course. It has been suggested that studying the double science course rather than the 'triple science' course, allows students more choice to study a broader educational programme at GCSE.

Heads of Science from our local schools have acknowledged that teachers show enthusiasm for their own particular area of expertise, hence some topics of a double science course may be taught better than others. Within the Science departments of all of our partner schools, there are more biology teachers within the science department than those with chemistry or physics backgrounds. For example, School M, which is partnered with the college has eleven science teachers, of which there are six biology teachers (3 male, 3 female), 4 chemistry teachers (2 male, 2 female) and one physics teacher (male). This appears to be typical for state schools within the city, although other schools have quoted a higher ratio of female biology teachers.

Female physics teachers are rather unusual and whilst I have known two who worked at a local girls' school, both left the profession after less than three years of teaching. Therefore, if we wish to increase the numbers of young people who study physics, we need to address the problem of why physics teachers are under-represented in school science departments. Furthermore, by increasing the number of female physics teachers, we could possibly encourage more girls to study this subject at A level and university.

Local trends for GCSE Science Courses

In order to compare local trends with national trends, data was obtained from the city's Local Authority relating to the number of school pupils (from all state schools within the city) who were entered for science-related GCSEs in 2009.

The information provided in Tables 2 indicates that schools within the city were adhering to the policy of a 'balanced science' education in 2009, with the options of single, double or triple award science, but with the stipulation of an equal weighting to all three sciences.

TABLE 2: The number of young people entered for science GCSEs in the city (2009)

Subject	Girls	Boys	Total
Biology	203 (41.5%)	285 (58.5%)	488
Chemistry	203 (41.5%)	285 (58.5%)	488
Physics	203 (41.5%)	285 (58.5%)	488
Science (Core)	1262 (51.0%)	1210 (49.0)	2472
Science (additional)	776 (49.7%)	790 50.3%)	1560

TABLE 3: The number of young people entered for science GCSEs in the city (2010)

Subject	Girls	Boys	Total
Biology	209 (46.0%)	245 (54.0%)	454
Chemistry	201 (45.0%)	245 (55.0%)	446
Physics	184 (43.4%)	240 (56.6%)	424
Science (Core)	512 (45.1%)	621 (54.8%)	1133
Science (additional)	736 (50.0%)	736 (50.0%)	1472

In 2010, the schools appear to have removed the requirement to study a balanced science course, with different numbers of students being entered for the three main science GCSE subjects. This could be explained by the fact that schools are now allowed to offer the core science plus one specialist subject at GCSE. (Local Authority, November 2010).

For GCSE biology in 2010, 46.0% of the entrants were girls and 54.0% are boys. For GCSE chemistry, 45.1% of the entrants were girls and 54.9% were boys. For GCSE physics, 43.4% of the entrants were girls and 56.7 % were boys. The data for the Additional Science course appears to be completely gender-balanced (50% girls and 50% boys) and in accordance with the national trend of 50.8% girls.

Therefore, by evaluating the national and local trends for GCSE, it can be seen that for GCSE physics, the gender balance within the city's schools (43.4% girls) is similar to the national gender balance (44.8%). It is very reassuring to know that schools appear to be encouraging pupils to follow a balanced science course, and that there are no major differences in the number of pupils entered for each science GCSE. It is clear that both nationally and regionally, is the least popular GCSE of the three main sciences, but not a serious cause for concern. The fact that the gender balance in the city reflects the national trends for the various science courses, is very positive. It must be stressed, however, that this data reflects the decisions taken by pupils at the end of year nine, not at the time when the examinations were taken.

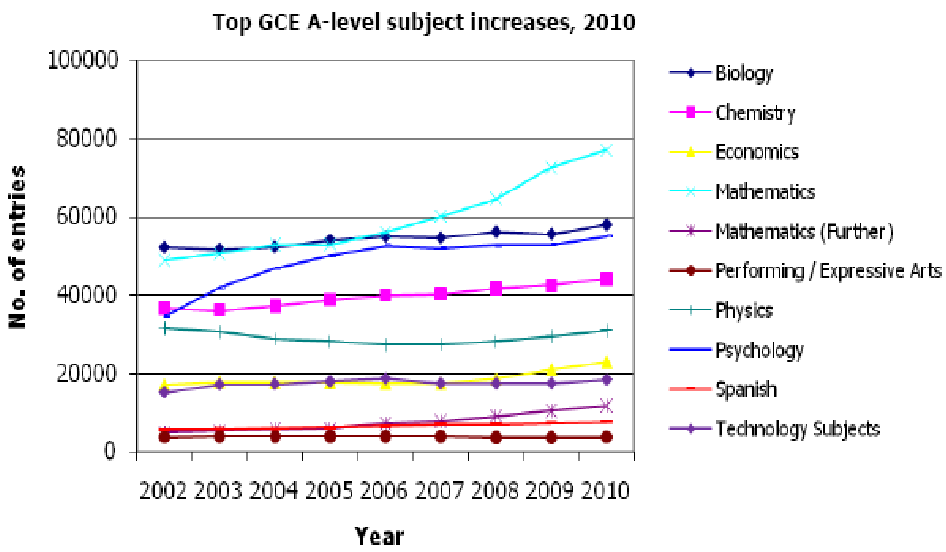
Part 3: The number of A level Physics Students

The Joint Council for Qualifications website provides national information regarding the number of students taking GCSE and GCE A level qualifications. The data for 2010 shows that the number of candidates for physics A level has increased from 28,096 in 2008 to 29,436 in 2009 (4.77%) and then a further increase to 30,976 in 2010. Therefore this is very pleasing to see that there has been a yearly increase in the number of A level physics candidates over the past three years (JCQ, A, 2010).

TABLE 4: The number of candidates for A level physics in 2009 and 2010

Year	Total number of candidates	Female	Male
2009	29, 436	6,538 (22.2%)	22,898
2010	30, 976	6,668 (21.5%)	24,308

CHART 1: The ten subjects that have increased in number in 2010



(JCQ, A, 2010)

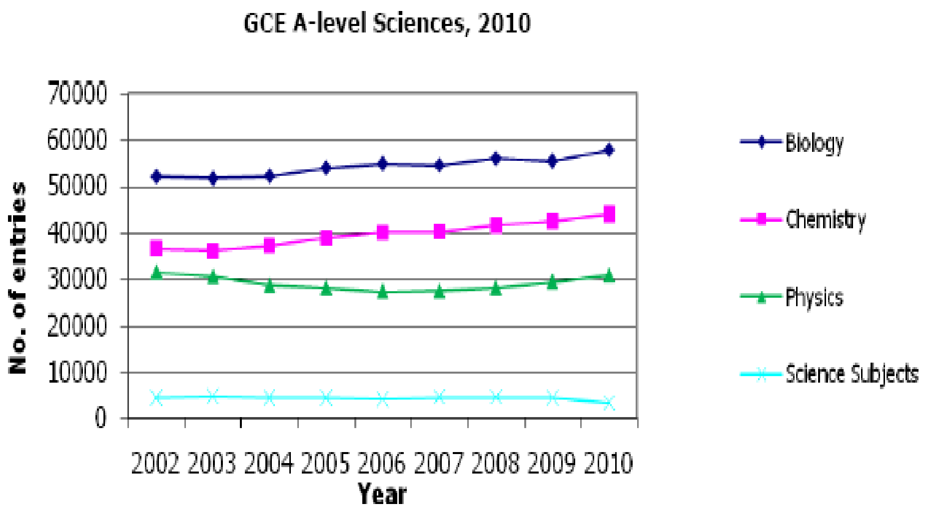
The number of A level candidates has increased at a steady pace over the past few years: 808, 657 in 2007, 827,737 in 2008, 846,977 in 2009 and 853,933 in 2010. The proportion of A level physics candidates as a percentage of the whole cohort of A level students was 3.47% in 2009 and has increased to 3.63% in 2010. The following table (Table 5) presents the most popular A level subjects in the UK in 2010, where it can be seen that physics was not one of the ten most popular subject choices in 2010 (JCQ, A, 2010).

TABLE 5: The most popular A level subjects (2010)

Subject	**Number of candidates**	**Female candidates**	**Male candidates**
1) English	89,320	62,393 (69.8%)	26,898
2) Mathematics	77,001	31,264 (40.6%)	45,737
3) Biology	57,854	32,636 (56.4%)	25,219
4) Psychology	54,940	40,138 (73.1%)	14,802
5) History	49,222	24,954 (50.1%)	24,268
6) General Studies	46,770	24,949 (53.3%)	21,821
7) Art & Design Subjects	46,054	33,535 (72.8%)	12,519
8) Chemistry	44,051	21,057 (47.8%)	22,994
9) Media/Film/TVStudies	33,375	18,012 (53.9%)	15,363
10) Geography	32,063	14,730 (45.9%)	17,337

(JCQ, A, 2010)

CHART 2: The number of A level candidates entered for Science A levels in 2010



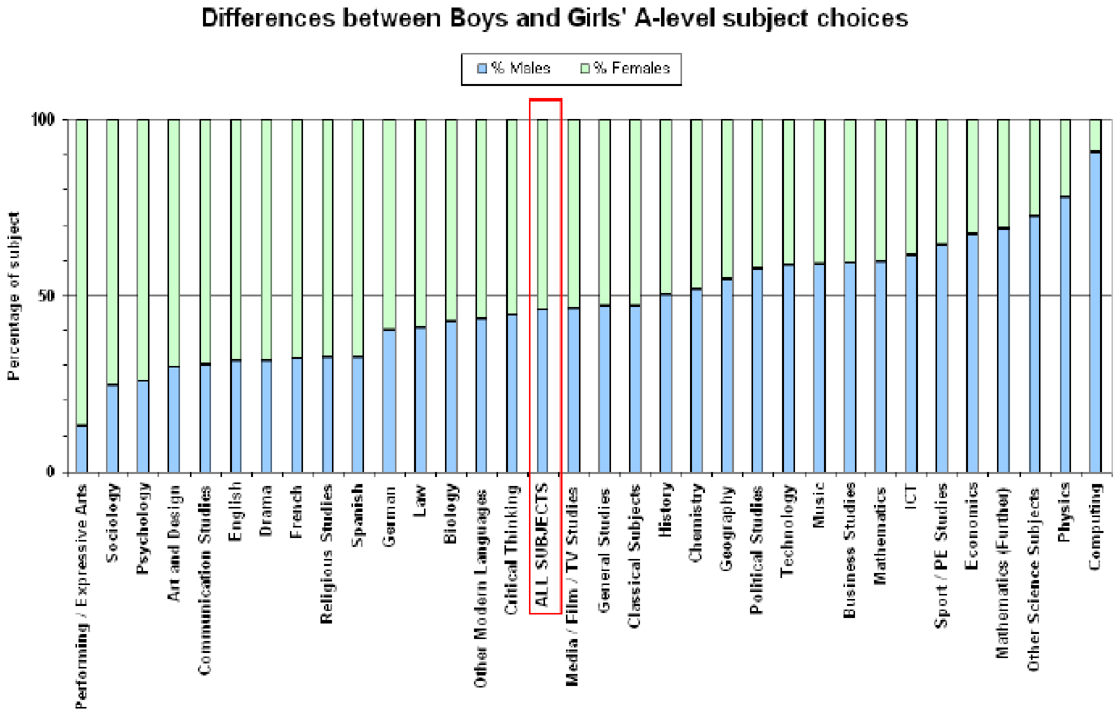
(JCQ, Trends, 2010)

One of the questions that must be asked is why physics is less popular than both biology and chemistry, which are both in the top ten A level subjects. The second question is to ask why there is still a gender imbalance in physics A level, particularly when compared to biology and chemistry A levels. Biology is particularly popular with girls, yet chemistry with 47.8% of the candidates being female, has eradicated its former gender imbalance. It could be argued that by exploring the reasons why girls choose not to study physics at A level could resolve, to some extent, the reason why physics is not in the top ten subjects.

In 2010, there were over 32,000 girls who chose to study biology A level, over 21,000 girls who chose to study chemistry and yet physics could not even reach up to 7,000 girls. If we actively encouraged more girls to study physics, for example, if we could increase the number of girls by another 10,000 (which would still be far less than the number of girls who study biology or chemistry) it would take the total number of physics A level students to 40,000 and make this a top ten subject.

If we consider the subject choices, it appears that there are some subjects which have a predominantly female bias, for example psychology with 73.1% of candidates being female and sociology where 22,345 out of the 29,665 candidates are female (75.3%). Art and Design also have 72.8% of the candidates being female. Whilst these subjects are valuable academic disciplines that are extremely worthwhile to study, perhaps physics could be a more useful and employable subject at this particular time of economic recession? The following chart is from the JCQ website in 2009 and presents a very clear representation of the gender bias in each A level subject.

CHART 3: The percentages of girls and boys entered for A level subjects.



(JCQ, Trends, 2010)

A report was produced by Daly, Grant and Bultitude (2009), outlining their findings from an action research project that they had conducted into the low participation of girls with A level physics. They claimed that in 2005, only 14% of the girls who had achieved either A of A* for GCSE physics or double award science had continued with the study of physics at Advanced level. ‘In other words, girls are making a conscious choice not to study physics even though they have the ability to succeed in the subject’. (Daly, Grant and Bultitude, 2009, p.iv)

Their research project, which was conducted between 2005 and 2008, involved the consideration of some of the following issues: school culture and ethos, teaching and learning strategies within the classroom and careers education, as well as monitoring progression and employment opportunities. After exploring the influence of these factors, many of which are beyond the control of a classroom practitioner, the report made several recommendations that could be developed within the classroom. These recommendations included talking to students more often about how they feel about physics, linking topics with career opportunities and being aware of students’ aspirations. They also recommended that physics teachers engage with action research projects in order to continually reflect upon classroom practice (p.61 – 63). The July 2009 issue of Physics Education featured an article about this project, with the following extract:

> ‘When you look at the challenges that we face, from climate change and energy insecurity to an ageing population and adjustment towards a digital economy, we need more of the next generation of school and university leavers to be scientifically trained. Physics is the underpinning scientific discipline, yet the subject’s importance and appeal has been missed by thousands of young females who haven’t been able to connect with it. If the number of girls doing physics at A level matched the number of boys, among whom it’s the sixth most popular subject at A level, we would very quickly approach the national targets for a scientifically trained population and, just as importantly, girls would have an equal opportunity to enjoy a fascinating subject from which many are currently excluded.’
>
> (Physics Education News, 2009, p.325)

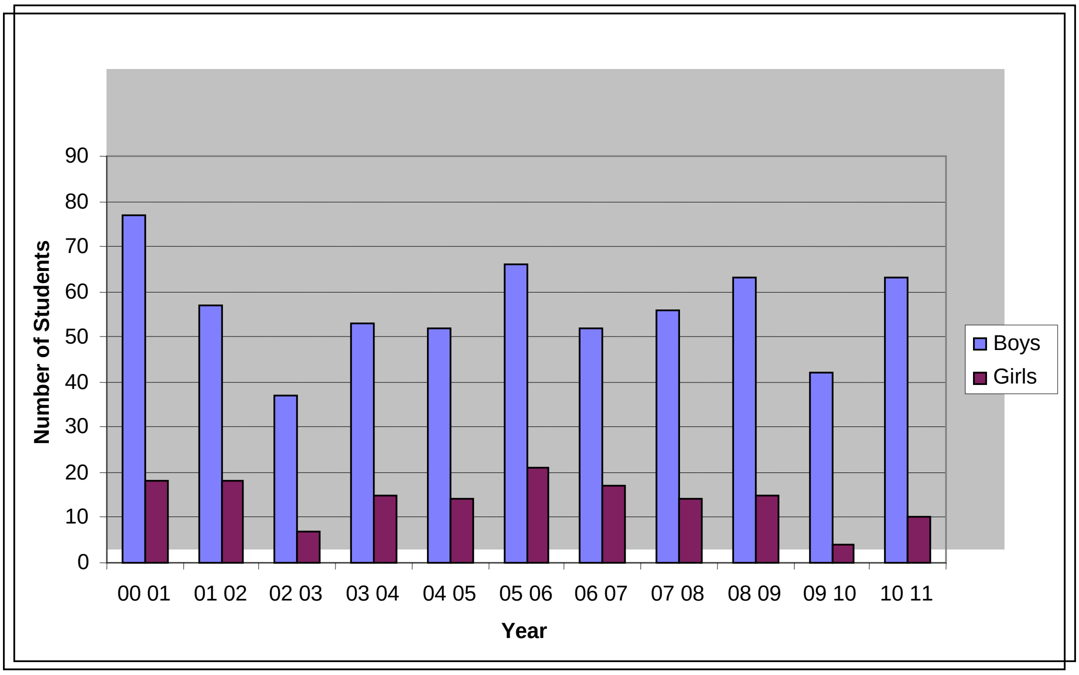
Local trends for A level Physics

To what extent does the city compare with the national trends? Also, is the college representative of the wider trends within the region? At present the FEC is the main provider of A level education within the city. In 1989, a restructure of the schools in the city removed all A level provision from most of the schools and created a tertiary system where post-compulsory education was provided by the city's two colleges of Further Education. The only exceptions to this restructure were the three Roman Catholic schools, where each retained A level provision within their schools. In 1996, the two colleges merged to form the current FEC, which remains the city's main post-compulsory provider of education. As a Widening Participation college with an agenda to increase the number of students in full time post-16 education, 'A' levels are only a fraction of the wide range of level 1, 2, 3 and 4 courses that are delivered within the college.

In the past four years, the college has reshaped its sixth from provision into three separate sixth forms, each based in a different part of the city with its own identity and ethos, yet all part of the FEC organisation. These three sixth forms provide post-compulsory education for 14 secondary schools, as well as offering places to students from the other 3 Roman Catholic schools, if they should wish to study at the college. If we compare A level trends at the college with the three Roman Catholic schools in the city, it may be that subject trends at the college are not the same as within other institutions?

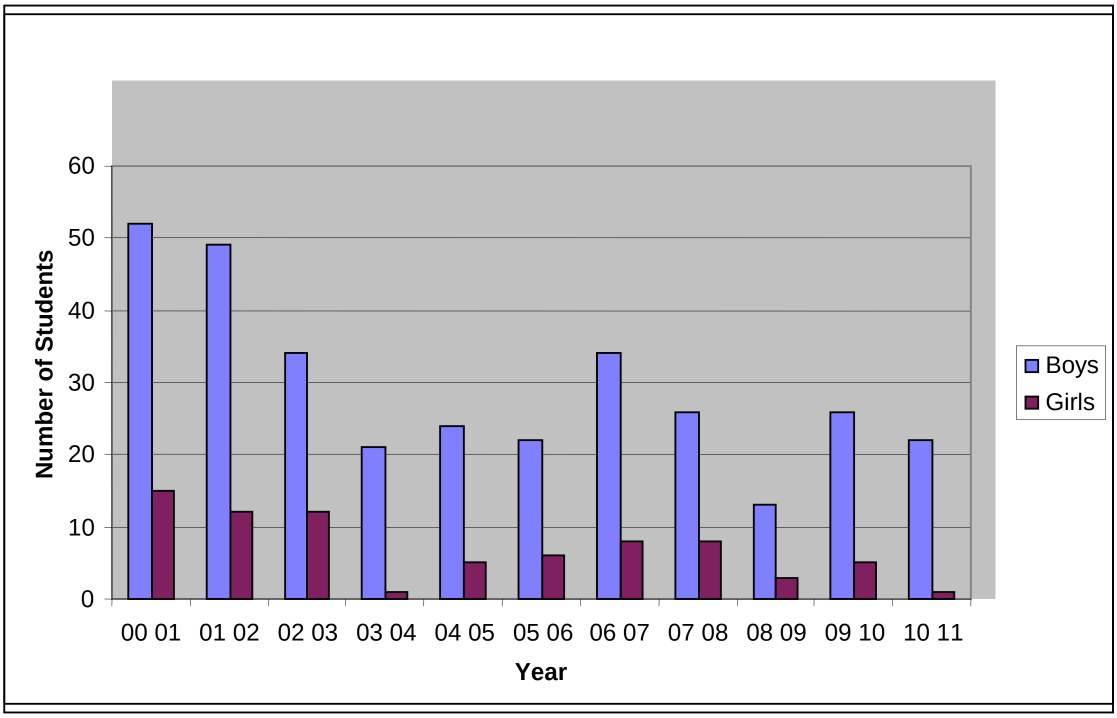
If we consider the number of students studying AS physics (first year of the A level course), there was a maximum of 95 students in 2000, but the number of AS students has shown a fluctuating pattern since then.

CHART 4: The number of AS Physics students at the FEC (2000 to 2010), showing the gender balance of each year group



It can be seen from Chart 4 that girls are still a minority group and this is an area of particular concern. During the academic year 2010 to 2011, there were 6 girls at Sixth Form B, four girls at Sixth Form U and no girls at all in AS Physics at Sixth Form S. Therefore, for the AS year 2010/11, only 10 out of 53 students are female (18.8%). The pattern for the male/female ratio in A2 Physics is more alarming with very few girls continuing this subject into the full A level. During the academic year 2010 to 2011 there is only one girl (out of 23 students) who is studying A2 physics (4.3%).

CHART 5: The gender balance of A2 Physics at the FEC.



Within the college, we maintain strong links with our partner schools. In order to ascertain why the numbers of girls who had chosen to study physics was so low, I asked the Heads of Science from these respective schools if they could provide any feedback that may provide an insight into this dilemma. After conducting focus groups with groups of girls aged between fourteen and sixteen, the Heads of Science provided the following comments:

1) Girls do not seem to like physics or find it boring
2) There were too many calculations and formulae
3) It was not relevant to a future career
4) Subjects such as English and Drama were more appealing to girls in this geographical area.

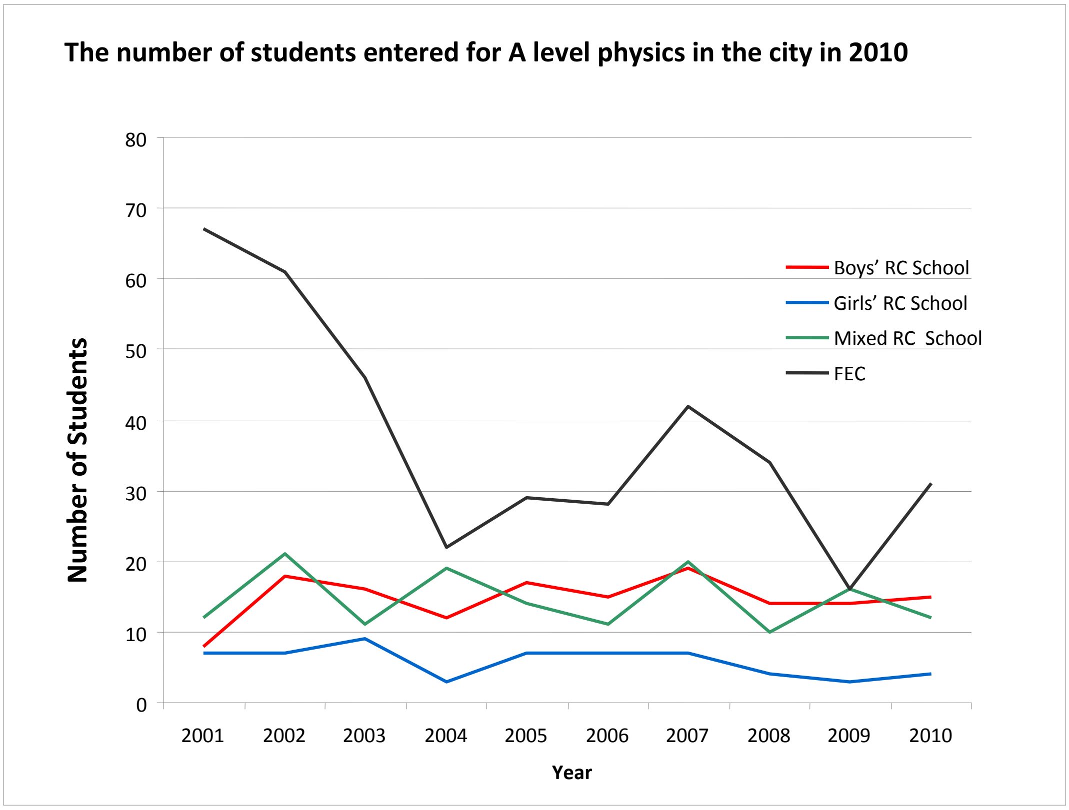
The Head of Science from one of the schools provided a personal opinion of why girls were not choosing to study A level physics:

> ‘Trying to make a very dry syllabus accessible is a challenge. The Units are not exactly captivating and often the pupils can't see the relevance to their future career, so it IS a challenge to make the lessons so they will engage! Practical opportunities are limited due to the cost of equipment and syllabus content.’
>
> (Private email communication 26/1/2010)

This opinion claims that it is an effort to engage students into the study of physics, although to what extent is this related to science or education as a whole? Increasingly teachers are expected to engage students who do not see any value for education, nor come from backgrounds which encourage children to thrive academically. As mentioned earlier in this report, I discovered that physics teachers are seriously under-represented in school science departments. From each of the replies received from partner schools, it was clear that each had more biology teachers than chemistry or physics teachers, so the above reply represents more of a teacher’s perspective than students. If students are being taught by teachers who think that physics is boring, then it may be a very strong reason for the low numbers that study this subject at A level.

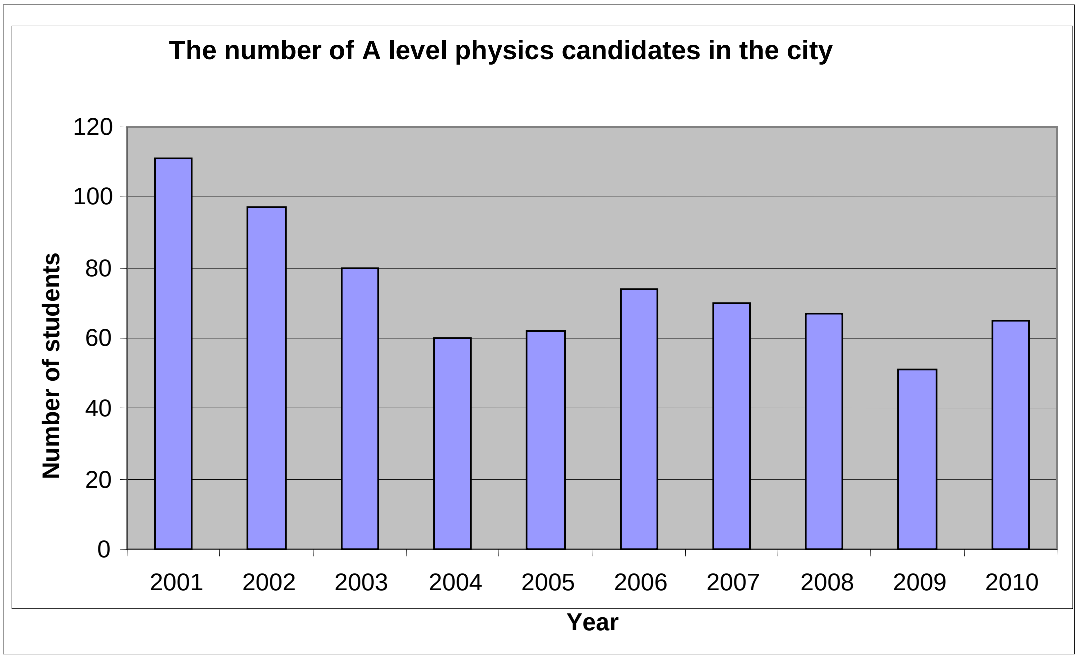
In order to extend this study, I have also analysed the data (obtained from the Local Authority) for the numbers of physics A level students at the three schools which have sixth forms. St. R’s is an 11 to 18 mixed Roman Catholic comprehensive school, and as places are limited, has a reputation within the area for being selective and therefore prestigious. There are two single sex schools which are also Roman Catholic. There is no other provision for state education within the city, although there is one private school for which data relating to this study was unavailable.

CHART 6: The number of A level physics students at different educational institutions within the city



At the mixed RC Sixth Form, there was a decrease in 2003, but at both of the single sex schools, the decrease appears to be in 2004. Due to the small numbers of students in these schools, a cumulative line was drawn (see below), which represents all of the students in the city. If we consider the number of A level physics students at the all girls school, the maximum class size was 9 students in the past ten years and in 2010, there were only five A level physics students.

CHART 7: The total number of A level physics students in the city



Despite considerable investigation into what factors could have caused the decrease in popularity between 2001 and 2004, there does not appear to be any satisfactory reason to account for this sudden drop. It has been suggested that this could be due to an increase in the availability of other A level subjects in the school sixth forms that were previously not available, such as law, psychology and sociology. It has also been suggested that this may reflect staffing changes at the different establishments, although this may be difficult to determine from the other A level providers. It is interesting to note that in the academic year 2009/2010, there were 31 students who are studying A level physics at the college (which is essentially the sixth form provider for 14 secondary schools in the city), which is exactly the same number as those at the three R.C. schools.

Whilst conducting research for this section, one of the obstacles that I encountered was that information relating to students prior to 2000/1 was unobtainable from the FEC records department. It emerged that previous data had been destroyed in accordance with the Data Protection Act. It would have been interesting to have information prior to 2000 in order to conduct a more rigorous study and explore the longer term trends in the popularity of science within the city.

Part 4: Why is there is a problem with the progression from GCSE to A level physics?

In part 2 of this report, we found that the number of students taking GCSE physics has increased over the past ten years, and there has been an increase in the proportion of girls who study GCSE physics. JCQ data shows that nationally, girls represent 44.8% of physics GCSE candidates and within the city, 43.4% of the physics GCSE candidates are girls, showing a strong correlation between national and regional trends.

In part 3 of the report, we found that the national number of candidates for A level physics increased from 29,436 in 2009 to 30,976 in 2010, however, the percentage of girls has decreased slightly from 22.2% to 21.5%. At the FEC, there were 31 A level physics candidates in 2010, of which 5 were girls (16.1%). By exploring the reasons why young people choose not to study physics at A level, with girls as an important subset of this group, could help to clarify the situation and we could then seek to redress the situation.

Due to an emphasis upon balanced science in schools, there are no major discrepancies between the three main science subjects at GCSE. The problem appears to be with the number of students, both male and female, who progress from GCSE physics to A level physics. In order to gain a wider insight in why students were not choosing to study physics at A level, I held a small focus group with some second year students at the college who had chosen to study A level Chemistry but not A level Physics. The students who contributed towards this focus group have been given letters to ensure anonymity (see Table 6).

The male student in the group (A) expressed regret at not choosing to study physics at A level, as many of his friends studied the subject and they enjoyed the lessons. Student A said that he selected his subjects in order to provide a strong foundation for a career in medicine, however he had not particularly liked the subject content of GCSE physics at school.

TABLE 6: Students who participated in the focus group to consider A level subject choice

Student reference	**Male or Female**	**A level Subjects**	**Career Choice**
A	M	Chemistry, Biology and Mathematics	Medicine
B	F	Chemistry, Biology and Mathematics	Pharmacy
C	F	Chemistry, Biology and Psychology	Pharmacy
D	F	Chemistry, Biology and Psychology	Pharmacy
E	F	Chemistry, Computing and Mathematics	Computing

The four female students in the group had all thought carefully about which subjects to study for A level, and three of the four students were clearly focussed upon a career in pharmacy. They all found that the GCSE physics course was rather dry, which corroborates the quotation from the Head of Science earlier in this report. The girls commented on the fact that physics teachers in schools tend to be men, or taught by teachers for whom physics was not their main subject and perhaps did not exhibit a great enthusiasm for the subject.

Three of the girls said that if there had been female physics teachers at their schools, this may have encouraged them to consider the study of physics at college. It was difficult for the students to maintain an objective approach and I had to steer them away from personal or subjective comments, yet this served to prove an important point in that the personal qualities of a teacher are paramount.

Jones and Kirk (1990) conducted a survey with 15 to 16 year old students in New Zealand and found that differences emerged in girls' and boys' preferences for different topics, although they found neither boys nor girls were interested in domestic appliances. Girls preferred medical applications whereas boys preferred technological devices (Jones and Kirk, 1990, p.312). As this research paper is over twenty years old, I devised a new list of topics which I showed to the students, containing a range of topics that were associated with physics.

It was interesting to see that out of a range of 18 possible topics, none of the four girls were interested in the physics of the home, yet all four were interested in medical physics and astronomy. The interest in medical physics was consistent with Jones' and Kirk's findings, however they did not directly include space or astronomy in their survey.

My findings with this small focus group agreed with some of the factors outlined in section one as 'making a difference':

1) The teachers – this refers to the teachers of physics up to GCSE, who have the most significant influence upon why young people engage with particular subjects and select subjects to study for A level. None of the girls who participated in the focus group had been taught physics by a female teacher. The girls believed that male physics teachers related better with boys and focussed the lesson on their needs. Whilst students used expressions that were more in line with their vocabulary, such as 'nerdy', it appeared that inter-personal skills and empathy were strongly missing from some of the school physics teachers. All of the students claimed that they had been taught physics by chemistry or biology teachers for at least two of their five years of secondary education.

2) The subject content – the GCSE content and structure is a major influence, with young people forming opinions based upon this stage of their education. It is of particular concern to this study that the proportion of girls

who choose to study GCSE is relatively strong, but once pupils complete this stage of their education, fewer girls wish to continue their studies of physics than boys. The young people who participated in the focus group claimed to have chosen to study science, not out of interest, but of a necessity for a future career. The students in the group said that they had not learned anything new for GCSE physics, but rather covered the same ground that had been covered in years 7 to 9 of their education. The content, however, was far less of an important factor than the teacher, which was clearly the most important factor in deciding not to study physics at A level.

3) Relevance for future career – all of the five students in the focus group had decided upon a future career prior to enrolling at the college. They already made up their mind about which A levels they were going to study based upon their experience of GCSE. This indicates that if we wish to encourage more young people to study physics at A level, we must ensure that stronger careers advice and college liaison takes place at an earlier stage of their education.

4) Wider influences such as parents, careers advisors and friends were all mentioned, although these were all insignificant compared to the ‘teacher effect’. The Institute of Physics report ‘Girls in the Physics Classroom’ (Murphy and Whitelegg, 2006) explores some of the reasons why girls choose not to study physics. Whilst they concur with the reasons given above, they also include perceptions of difficulty as a significant factor, claiming that the idea that physics was harder than other subjects was one of the main reasons that deterred young people from studying this subject at A level. (Murphy and Whitelegg, IOP, 2006, p.36)

The students who participated in the focus group did not mention this reason at all, perhaps due to the fact that they were all very able students who had achieved A or A* at GCSE. This is clearly a reason that deters many young people from studying physics at A level, but for the purpose of this small focus group, I had wanted to explore the reasons why intelligent and high achieving students had ‘walked away’ from physics A level.

Conclusion

Part one of this report considered some of the national reports that have been produced in order to increase the number of students who study science, particularly at GCSE and at A level. The reports indicate that there is a problem in attracting young people to study science, despite a range of initiatives and incentives. The Science Learning Centres have been created in order to ensure quality training and continuous professional development for practicing science teachers. STEMNET has been created to provide further external support, including the STEM ambassador scheme, which is a data base of over 30,000 scientists who can act as role models as well as organise events.

In part two, the trends for GCSE science courses were discussed. In 2010, there were 120,455 candidates for GCSE physics, of which 44.8% were girls. Within the city, the proportion of girls taking GCSE physics was 43.4%, which does mirror the national trend.

Part three considered the trends for A level physics, finding that this subject is surpassed in popularity by subjects such as psychology, history, geography and media studies. In 2010, there were almost twice as many candidates who were entered for A level biology (58,000) than for physics (31,000). In 2010, only 21.5% of the candidates for A level physics were female. It appears that one of the most direct ways of increasing the number of A level physics candidates is to explore the reasons why girls are not choosing to study physics.

Part four of the report discussed the findings from a small focus group that was held to determine the reasons why some young people choose not to study physics at A level. The group was small, as I wanted to restrict the group to students who had chosen other science A levels. The three most important factors that emerged were the influence of the teachers (who has taught them at school), the content of the GCSE course and relevance towards future careers. There were also other factors that were mentioned, such as parents, friends and careers advisors. The influence of the teacher is, however, paramount. The teacher is the main conveyor of enthusiasm, subject knowledge and professional expertise, yet within our partner schools, physics teachers are in a minority within a science department and almost invariably male. The girls in the focus group admitted that if they had a female physics teacher, it may have encouraged them to think differently about physics.

Considerable hard work has been invested by teachers, training agencies and support networks in order to encourage more young people (with girls as an important subgroup) to study physics at GCSE level. The number of pupils who choose to study physics at GCSE is increasing and the gender balance is almost equal. The main problem is clearly in the step between GCSE and A level, as we are loosing a considerable number of young people who would benefit from this subject at A level. Whilst not all young people wish to become scientists, the transferable skills of problem solving and applying numerical methods to real-life situations can be advantageous for a wide range of other diverse careers.

As a practicing physics teacher within a sixth form college, I try to motivate, enthuse and encourage my students to study physics at university. The students in my classes, however, have already made the conscious decision that they wanted to study physics at A level. We have limited opportunities for working with our partner schools, yet it seems that by increasing the number of physics teachers within a department, or by a conscious effort to increase the number of female physics teachers, may be one practical way of addressing the problem. Whilst an individual can not solve the problem alone, being aware of the issues, both nationally and locally can provide an important starting point for further research, with the ultimate aim of increasing the number of young people who can enjoy, as well as achieve success with A level physics.

References

AQA (2010) *Science Specifications* [Online] Available at: http://web.aqa.org.uk/qual/newgcses/science/new/sciencea_materials.php (Accessed: 20 July 2010)

CBI (2008) *Taking Stock: the CBI Education and Skills Survey 2008,* [Online] Available at: http://www.cbi.org.uk/pdf/eduskills0408.pdf (Accessed: 20 October 2010)

Daly, A., Grant, L. and Bultitude, K. (2009) *Girls into Physics: Action Research Report* (DCSF –RR103) [Online] Available at: http://www.dcsf.gov.uk/research/data/uploadfiles/DCSF-RR103(R).pdf (Accessed: 18 July 2010)

Department for Education and Skills (2006) *STEM Programme Report* [Online] Available at: http://www.ima.org.uk/Education/stemprogrammereportoct2006.pdf (Accessed: 15 December 2010)

DIUS (2008) *Annual Innovation Report (2008)* [Online] Available at: http://www.dius.gov.uk/policy/annual_innovation_report.html (Accessed: 15 December 2010)

Edexcel (2010) *GCSE Science Specifications* [Online] Available at: http://www.edexcel.com/quals/gcse/gcse-leg/science/science/Pages/default.aspx (Accessed: 23 November 2010)

HM Treasury (2004) *Science and Innovation Investment Framework 2004 – 2014*, [Online] Available at: http://www.hm-treasury.gov.uk/spending_sr04_science.htm (Accessed: 25 July 2010)

HM Treasury (2002) *SET for Success: The supply of people with science, technology, engineering and mathematics skills* (*The Roberts Review),* [Online] Available at: http://www.hm-treasury.gov.uk/roberts

(Accessed: 20 August 2010)

Hollins, M., Murphy, P., Ponchaud, B. and Whitelegg, E. (2006) *Girls in the Physics Classroom: A Teachers' Guide for Action,* London: Institute of Physics

JCQ, A (2010) *A level results* [Online] Available at: http://jcq.org.uk/attachments/published/1297/JCQ%20GCE%20Results%202010.pdf (Accessed: 15 September 2010)

JCQ, (2010) *Tables AS, A level and AEA trends 2010* [Online] Available at: http://www.jcq.org.uk/attachments/published/1303/02.%20Appendix%20-%20GCE%20Tables.pdf (Accessed: 20 October 2010)

JCQ, GCSE (2010) *GCSE results* [Online] Available at: http://www.jcq.org.uk/attachments/published/1321/GCSE%20Results%20Handout.pdf (Accessed: 20 October 2010)

Jones, A.T. and Kirk, C.M. (1990) ‘Gender Differences in students’ interests in applications of school physics’, *Physics Education*, 25, pp.308 – 313.

Murphy, P and Whitelegg, E. (2006) *Girls in the Physics Classroom: A Review of the Research on the Participation of Girls in Physics,* London: Institute of Physics.

OCR (2010) *GCSE Science Specifications* [Online] Available at http://www.ocr.org.uk/qualifications/gcse/science/explained.html (Accessed: 23 November 2010)

Physics Education News (2009) ‘Girls in Physics: Getting girls engaged with physics’ *Physics Education*, 44, pp.325 - 326

Smith, H (2007) *STEM Review: The Science, Technology, Engineering, Maths Supply Chain,* London: The Council for Industry and Higher Education, UK

Report Evaluation Form

REPORT:

Progression from GCSE to A level physics

Reviewer:

Head of Sixth Form (FEC)

Comments on the report:

This is a useful report for identifying the issues with physics and exploring ways of increasing the uptake of physics at A level.

Are there things that could be added or removed to improve it?

Suggest possible strategies for increasing the number of students who study A level physics.

In what way could the contents of this report influence the wider profession?

The key factors identified here may apply to other colleges in the region. Other colleges may find the report useful.

Marianne has shared this report with a consultant from the Institute of Physics and now works with this person on a regular basis. Together, they organised the Ashfield Music Festival at the end of year, a one day event for pupils from our partner schools. This was very successful, not just for promoting physics but for promoting the college within the city.

Signature: **Supplied**

Report Evaluation Form

REPORT:

Progression from GCSE to A level physics

Reviewer:

Consultant from the Stimulating Physics Network (Institute of Physics)

Comments on the report:

The report provides a comprehensive review of relevant literature and a detailed look at the uptake of 11-18 physics courses in the city. It makes very interesting reading and supports (and builds upon) evidence produced in reports for the Institute of Physics.The report raises some questions which are detailed in the next box, although it is recognised that this might not be the appropriate place for the comments.

Are there things that could be added or removed to improve it?

Although possibly outside the scope of this report, it would be useful to have a comparison with the figures in a similar local authority which has a post-compulsory sector which has a majority of schools with an 11-18 provision.

Is there any evidence, perhaps from OFSTED reports or examination results, about the quality of science teaching in the 11-16 schools?

Are there female physics teachers who can act as role models in the schools? What careers advice is being given in schools?

In what way could the contents of this report influence the wider profession?

I have passed the report (with Marianne’s permission) to members of the education department at the Institute of Physics.

I have also asked the editor of *Physics Education* if he would be interested in an article based on this report.

Signature: Supplied