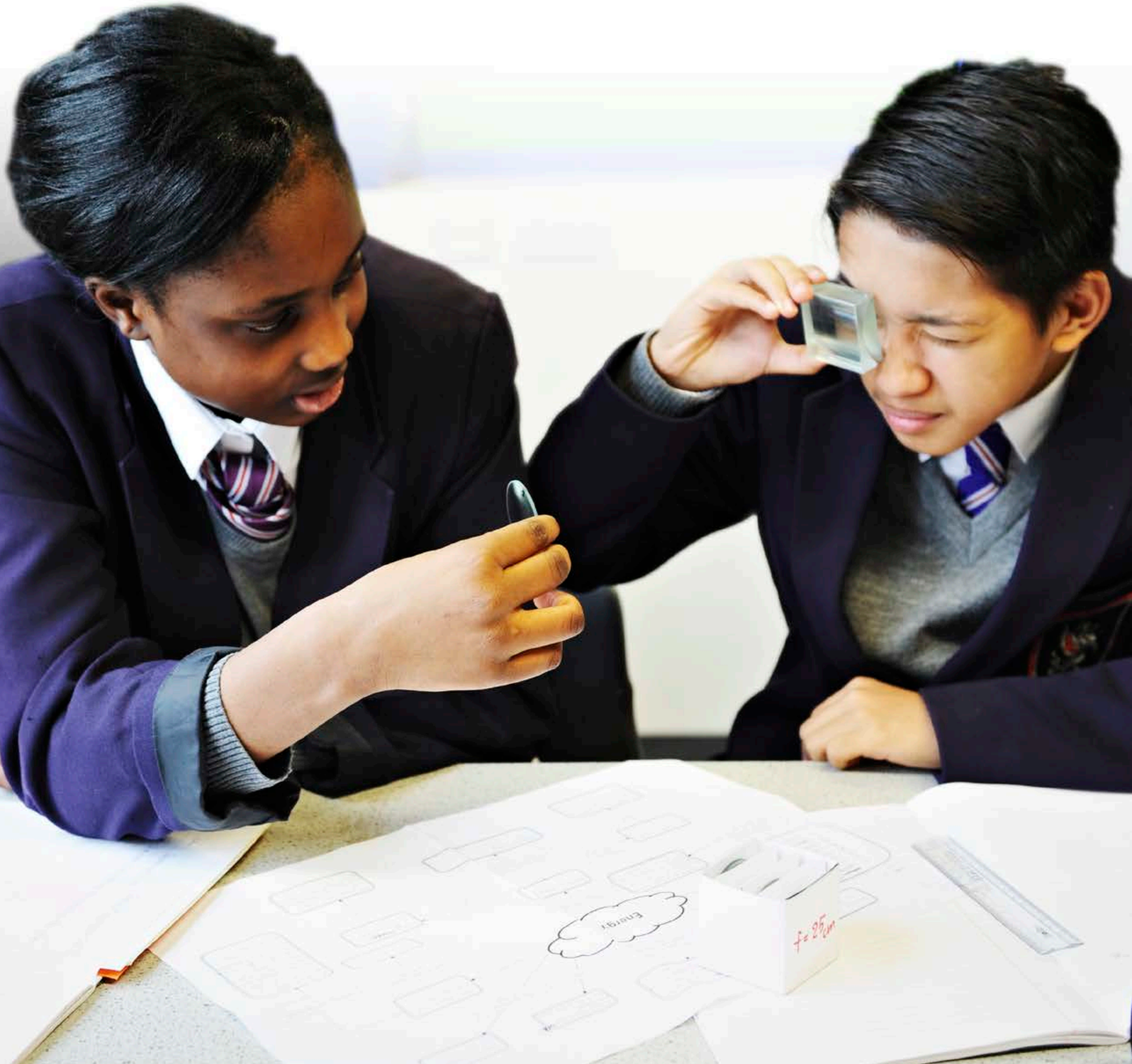
An Institute of Physics report | **November 2014**

Raising Aspirations in Physics

A school case study



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Acknowledgements
We would like to thank Sarah Watt for her generous funding of the Raising Aspirations in Physics project, without which this work would not have been possible. We would also like to thank the school for their hospitality and engagement with the project.

Contents

1

Introduction

[1] More information see **http://dashboard.ofsted.gov.uk/**

[2] Pupils with at least one of the following SES indicators: eligible for FSM, eligible for Pupil premium, from a household in the lowest 10% IMD (index of multiple deprivation)

The Raising Aspirations in Physics (RAP) project was a three-year pilot to investigate the barriers that prevent young people from lower socio-economic backgrounds choosing to take physics (and to a certain extent other sciences) post-16.

The project took place in a very large state mixed comprehensive school in the North East of England. This school has a large number of pupils eligible for free school meals (FSM) ranked in the highest quintile of schools nationally according to Ofsted's data dashboard[1]. When other indicators of socio-economic status[2] (SES) are taken into account, approximately half the children in the school have at least one indicator associated with a household with lower SES. The areas surrounding the school have various levels of deprivation ranging from the bottom 10% to the top 30% of wards nationally, using the Index of Multiple Deprivation.

The project involved working with pupils, parents and teachers in an attempt to identify the barriers facing lower SES pupils from continuing with physics post-16. Reviewing the literature indicated that the largest impact would occur with students before they start their GCSE exams when they are still uncertain about what they want to do in the future and their aspirations are still high, but their attitudes towards science, especially physics, are starting to become more negative.

The interventions were based on recommendations from a review of the literature carried out as part of the project.

Summary of project

2.1. School profile

The school has a large science department with 18 science teachers, 11 of whom have a specialism in biology. During the project, the number of teachers with a specialism in physics increased from three to four; the head of physics left the school in July 2013, and an NQT and a Teach First student with physics specialism started in September 2012 and 2013 respectively.

In 2014, one of the physics teachers and one of the chemistry teachers were Teach First students. Just 11/18 of the teachers in 2014 were the same as in 2012.

Analysis of pupil data from the school in 2011/12 and 2013/14 showed that the pupils from lower SES groups were predominantly found in the more vocational science sets (e.g. OCR nationals/BTEC/single GCSE). These pupils did not necessarily show aptitude for vocational work but were often seen as not able to cope with the more academic qualifications. Prior attainment is strongly linked to SES so this pattern is not unexpected and has been reported elsewhere (Gorard and Bevins, 2008[3]). This project was set up to investigate the barriers that might prevent high-achieving pupils from taking AS/A-level physics. Therefore, the higher ability science groups taking triple science GCSE were targeted. In the triple science sets, approx. 30–40%[4] of the pupils had an SES indicator. However, for logistical reasons, wider groups of pupils and their families were invited to take part in some interventions.

2.2. Interventions suggested by the literature review

- **Raise attainment with effective in-school measures**
  - Instigate peer learning programmes to increase attainment, build self-confidence and develop presentation skills
  - Provide training to improve teaching
- **Develop home–school partnerships**
  - Integrate parental engagement into a whole school approach
- **Provide appropriate advice on routes through education**
  - Ensure careers advice starts early enough (before year 9), is bespoke to students and their current aspirations, concentrates on the next stage of choice and includes parents
  - Provide information on how to access higher education and which subjects are desired by universities
- **Increase science capital**
  - Raise overall profile of science in the school
- **Improve awareness of further and higher education**
  - Provide schools with information about appropriate subjects and courses to study at school that are required to apply for their HE STEM courses
  - Provide opportunities for families to increase their science capital.

The term "science capital"[5] is used here to describe the cultural enrichment of children in a pro-science environment. The majority of children and their families can be said to lack science capital and this is especially the case for families from lower SES backgrounds. These groups have limited experience of engagement with science and little experience of informal science learning.

In order to implement these recommendations, interventions were carried out with pupils, staff and families. The project also needed backing from a senior management level within the school. The activities that were carried out and their fit with the recommendations are summarised in figure 1, p6.

[3] *Exploring the relationship between socioeconomic status and participation and attainment in science education* by Stephen Gorard and Stuart Bevins, The Royal Society, 2008

[4] The number of pupils classified as lower SES in the school as a whole increased during the project as the pupil premium measure was incorporated into the school data

[5] ASPIRES 2013 Young people's science and career aspirations, age 10–14, KCL, **www.kcl.ac.uk**

2.3. Working with pupils

The initial plan was to start working with the year 9 pupils in 2011/12 and to add the incoming year 9 pupils in each academic year while continuing to work with the existing cohorts. This approach did not always work as planned due to school constraints, such as pupils being unable to be released from certain lessons. Therefore, classes and year groups other than the target group were involved in some of the activities.

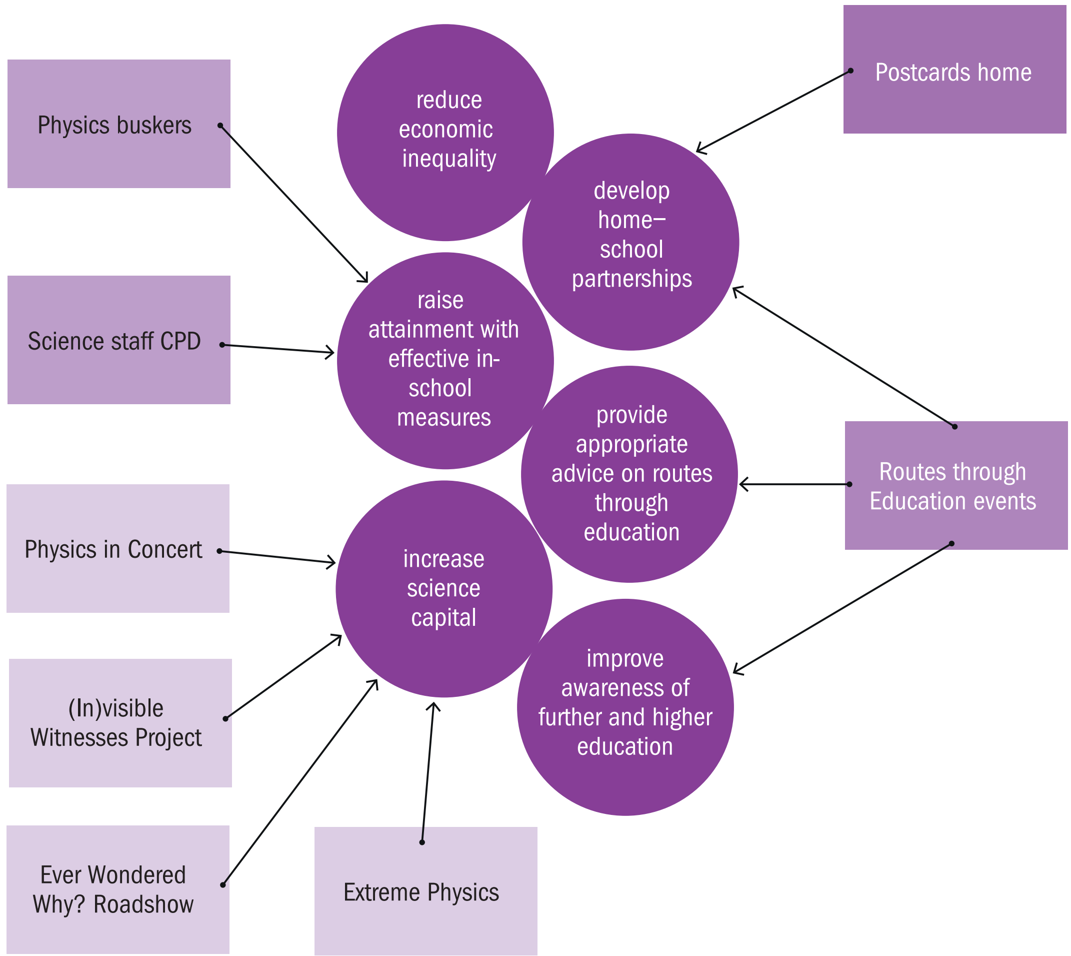
2.3.1. Ever Wondered Why? Roadshow

The *Ever Wondered Why? Roadshow* is a travelling show delivered by staff from IOP. It is designed to work with large audiences and enthuse students with physics applied to the world around them. The show was used to launch the project with the aim of reaching large numbers of pupils and staff and encourage them to start thinking about physics as part of their wider world. The show was delivered a second time in the second year of the project at the request of the science department who felt that the pupils had benefitted from it in the previous year.

2.3.2. (In)visible Witnesses Project

In the second year of the project, 29 year 8 pupils (cohort 2) took part in an Open

Figure 1: Project interventions mapped onto recommendations



University research project for a full day. The aim of this project was to investigate how representations of science in television programmes contributed to the students' self concept in science and physics. They took part in a number of mainly paper-based activities to identify STEM stereotypes in television programmes and to imagine themselves in a STEM career. For the main activity, the pupils had to design a STEM-related TV show, plan the first episode and present it to the rest of the class.

2.3.3. Physics in Concert

The school requested a science event for 120 year 9 pupils during an enrichment week. The IOP has a number of existing activities and resources, two of which are *Ashfield Music Festival* and *Physics in Concert.* These are run in the context of setting up a music festival and exploring the different types of engineering roles where physics knowledge is needed. The activities are paper-based and after discussion with the teachers, were adapted to include practical activities in the morning and poster making and presentations in the afternoon.

2.3.4. Extreme Physics

Extreme Physics is a residential event for teams of four year 10 pupils organised and heavily subsidised by The Ogden Trust. The three-day event is designed to encourage pupils to study physics post-16. It involves team and individual challenges as well as physical activities such as simulated skydiving or a high ropes challenge. One team was sent to events in 2012 and 2013, two teams were sent in 2014.

2.3.5. Physics Buskers

The Sutton Trust Toolkit for increasing attainment in schools (Higgins, Kokotsaki, and Coe, 2011[6]) suggests that peer learning has a high impact for both parties especially in cross-age tutoring. Previous studies have however focused on maths and reading rather than science.

A physics buskers club was set up in the first year of the project to initiate a culture of peer learning within the school. The aim was to train a group of low SES year 9 students, who would then help to train and mentor subsequent year 9 students as the project progressed. This approach would also build in some sustainability after the project finished.

Pupils involved in the intervention attended a number of training sessions and were invited to present at various events both in and out of school. They also helped to train their peers in lower year groups. In the second year of the project the peer learning stalled after an initial training session. In the third year of the project a new member of staff took responsibility and the group was restarted with the new year 9 students.

2.4. Working with parents

2.4.1. Postcards home

A US study suggested that sending brochures about STEM careers home to parents had a small but significant influence on the length of time students studied science and maths (Harackiewicz, Rozek, Hulleman and Hyde, 2012[7]). Sending physics postcards home was an attempt to initially engage pupils' families with physics. An activity pack was sent home to parents of every year 9 pupil. The activity was chosen as it linked to the appropriate stage of the curriculum, could be linked to the theme of Christmas and had no health and safety issues. Any returned forms would be entered into a prize draw to win a £20 shopping voucher.

2.4.2. Routes through Education events

Previous reports have highlighted the lack of relevant careers advice for secondary school pupils. A team developed plans for three Routes through Education events aimed at pupils and their families.

The aims of these events were to:

- Increase the science capital of families that attended the event
- Highlight different routes through education

[6] *Toolkit of Strategies to Improve Learning: Summary for Schools Spending the Pupil Premium* by Steve Higgins, Dimitra Kokotsaki and Robert Coe, The Sutton Trust, 2011

[7] *Helping Parents to Motivate Adolescents in Mathematics and Science: An Experimental Test of a Utility-Value Intervention* by Judith M Harackiewicz, Christopher S Rozek, Chris S Hulleman and Janet S Hyde, *Psychological Science*, 2012

2: Summary of project

- Raise awareness of subjects that universities prefer at A-level[8]
- Highlight different types of careers that are available to parents and pupils
- Engage parents, as they are a key point of advice on options at school and beyond

Key messages:

- Physics and STEM subjects are valued by universities for a wide range of subjects
- There are good employment prospects for people with STEM qualifications

The format of the events was developed to create a relaxed environment where parents were encouraged to ask questions. The three events were all held alongside existing events where parents were coming into the school. The school felt that this would maximise the footfall through the exhibition and reach the largest numbers of families, as these events already had a good turnout. The events were: KS4 options evening, personalised learning day (PLD) and the post-16 options evening.

A separate toolkit for planning these events has been developed and is available from www.iop.org.

Exhibitors were recruited from STEM-related careers and those in which STEM qualifications are well received. Local organisations working in law and teaching were also invited as the baseline survey of pupils showed these to be popular career aspirations for pupils in the school. In order to make the event informal and encourage families to engage, exhibitors were asked to bring a hands-on activity or piece of equipment related to their work to act as a hook to engage families and initiate conversations. Pupils were encouraged to visit exhibitors by collecting different stamps at each stand that enabled them to enter a prize draw.

At each event there were between 11–15 exhibitors from local companies, universities and other organisations as well as the physics buskers to show off their activities to the families attending the event. Year 10 student helpers carried out a number of jobs such as taking photos, directing people to the event and they also had the opportunity to talk to the exhibitors themselves.

Table 1: Summary of activities carried out

	EWW show	EWW workshops	(In)visible witnesses project	Physics in Concert	Physics Busker training	Busking experience	Extreme Physics	Routes through Education
Cohort 1	73				26	7	4	Post-16 options events and PLD
Cohort 2	31	63	29	120 (plus 6 × year 13 helpers)	12	1	8	PLD
Cohort 3	60 200				8	8		KS4 options event[9] and PLD

Cohort 1 were in year 9 at the start of the project and year 11 at the end.
Cohort 2 were in year 8 at the start of the project and year 10 at the end.
Cohort 3 were in year 7 at the start of the project and year 9 at the end.
Four pupils from year 10 at the start of the project attended extreme physics in 2012 (i.e. the year group above cohort 1).

[8] The Russell Group of universities recommend having at least two A-levels in "facilitating subjects" in order to keep options open. Theses subjects are: mathematics and further mathematics, English (literature), physics, biology, chemistry, geography, history, languages (classical and modern) (The Russell Group, 2012)

[9] The school runs an extended KS4 so students choose their GCSE options (or equivalent) in year 8

2.5. Working with teachers

A number of continuing professional development (CPD) sessions were carried out in the school. These took place during scheduled CPD time in agreement with the head of science. The attendance at these sessions was very high. The sessions were carried out by trained IOP staff or by external consultants. See table 2 for a summary.

Table 2: Science teachers CPD

Academic years	Sessions					
2011/12	Introduction to project and baseline survey	Forces	Individual mentoring (schemes of work)	EM radiation	Electricity	Girls in Physics
2012/13	Misconceptions at A-level physics – KS5 physics teachers	"Do Physics"	Misconceptions at primary and KS2/KS3 transition	Review and follow up with KS5	Sound	Briefing to whole school staff
2013/14	Effective student feedback	Growth Mindsets	Review of project and refresher			

3

Main findings

3.1. Impact of interventions

The project began with baseline questionnaires for pupils, parents and science staff. The subsequent impact of the activities was measured using a number of methods:

- Questionnaires immediately after the activities
- Questionnaires of staff at the end of the project
- Focus groups with pupils and staff carried out by external evaluators. Small group interviews were undertaken with year 9 students in 2012 and in 2014 when they were towards the end of year 11. Staff were interviewed on a one-to-one basis about their opinions on teaching physics, the interventions for students and staff CPD (if relevant) at the end of the project

3.1.1. Impact of activities with students

Ever Wondered Why? Roadshow

The response to the *Ever Wondered Why? Roadshow* was overwhelmingly positive with more than 90% of the students rating the presentation, entertainment and educational aspects of the show as good or excellent. More than 75% of respondents said the show had made them look forward to their next physics lesson. In focus groups at the end of the project, students remembered the show in a positive light but its impact, in terms of their enthusiasm for physics, had decreased over time.

(In)visible Witnesses Project

The participants worked well in small groups and demonstrated a good understanding of the potential for STEM-related content to be integrated into television programmes that young people would find engaging. Some of the groups communicated their ideas well on paper through storyboards but their presentations to the rest of the class highlighted these types of communication skills were less well developed. The researchers suggested that more exposure to activities that support the development of these communication skills should help the young people overcome their self-consciousness and develop their confidence. A full report has been produced by the researchers (Whitelegg *et al.*, 2013[10]).

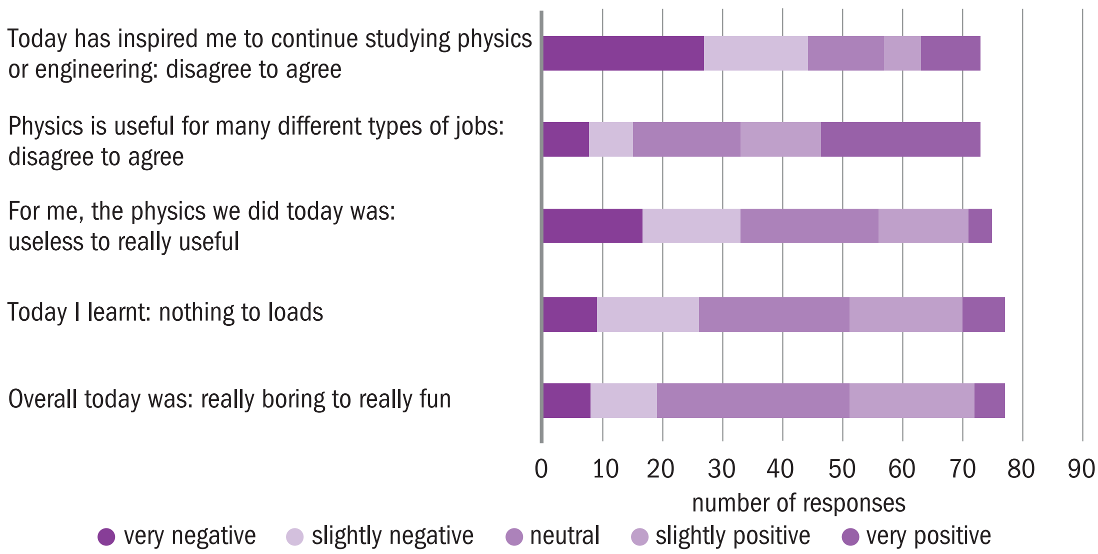
Physics in Concert

The majority of students engaged with the practical work and produced good posters.

This activity was run with a large cohort of mixed-ability pupils. The teachers thought that the day was challenging for the students and not

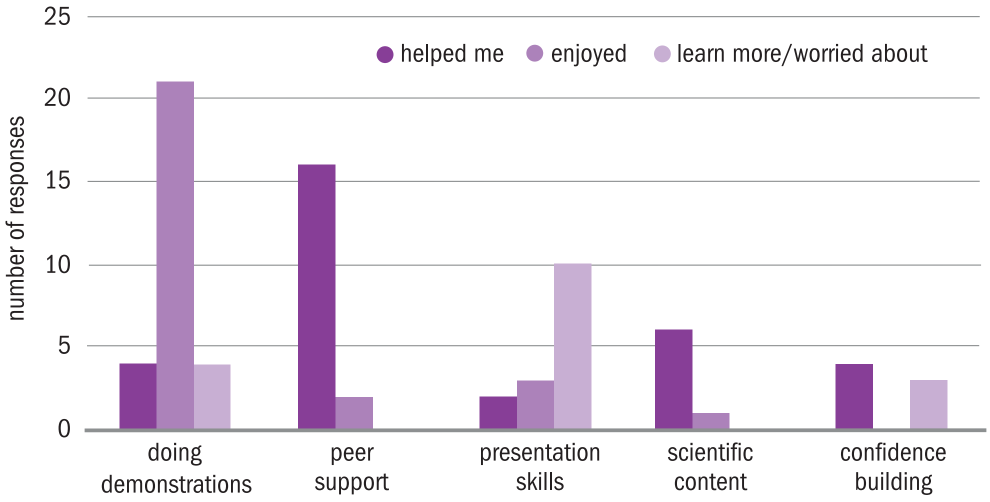
[10] Elizabeth Whitelegg, Jennifer Carr and Richard Holliman, *(In)visible Witnesses: Using creative media literacy skills to raise aspirations in STEM*, Milton Keynes: The Open University, 2013

Figure 2: Pupil feedback from the Physics in Concert day



Pupils were asked to fill in feedback forms in their groups (of four) by placing stickers on a Lickert scale. Some groups answered as individuals whereas some answered as a group. In total between 70–77 responses were received for each question.

Figure 3: Pupil feedback from presentation skills practice for physics buskers



Students were asked to write a free response to the questions: 1) One thing that has helped me today 2) One thing I enjoyed and 3) One thing I would like to learn more about or are worried about. The individual responses were grouped into the categories.

perceived as being as fun as the activities that the other half of the year group did. However, the feedback from pupils (figure 2) showed that less than a quarter of the groups thought it was boring. Most groups agreed that physics is useful for many different types of jobs. Many groups did not think that the physics they had done during the session was useful for them and most of them said it had not inspired them to continue studying physics or engineering. However, 16/73 (22%) agreed or strongly agreed that it had inspired them to continue studying physics or engineering.

Teams were also asked to comment on their best and worst parts of the day. The different practical activities in the morning were cited as being the best part of the day. The least appealing part of the day was cited overwhelmingly as giving the presentations. None of the groups said they enjoyed this and seven groups identified it as the worst part of the day.

In the focus groups the students remembered the activity and described it well. Some of the pupils mentioned they enjoyed the activity.

Extreme Physics

Although those that attended were small in number, the activity was very well received by the students. One of the pupils in cohort 1 who attended, described it as “great fun” and she had learned a lot and now she was interested in physics, which was why she was going to do it. Staff thought that the students came back with more than just physics knowledge and had increased confidence and presentation skills. Feedback recorded at the event was very positive from all pupils rating the challenges and the event in general, highly. However, no-one from this group who subsequently went on to study AS physics has an SES marker.

Physics Buskers

Feedback after the first training session, showed students overwhelmingly enjoyed the demonstrations and they found the peer support from working in small groups very helpful in allowing them to practise the demonstrations and their presentation skills. Working in this way also allowed the students to consolidate their scientific explanations for the different activities. A summary of the feedback is seen in figure 3. The biggest concern expressed by the group was presenting in front of other people. However, one respondent stated that they were looking forward to performing in front of other people.

The physics busking was the activity most mentioned by pupils during the final focus groups. The buskers felt that they had made other people more interested in science by busking at parent events after school. The students said that they had fun doing practical and experimental science and enjoyed showing experiments in and out of school. The intervention was successful in improving their confidence and presentation skills compared to the pupil responses after the first training session.

Three of the student buskers (in year 11) already had career plans that did not include physics at A-level (unchanged from year 9) but this experience had made them more positive towards physics. One boy was leaving school to get a job as he was fed up with education but said that if he was going to stay he would choose physics. They also thought that if this experience could have been integrated into lessons then it would have more impact.

As outlined above, there was a lack of continuity with the buskers, mainly due to staff changes within the school and gaining access to the groups of students. The initial plan to include previous buskers in training the subsequent groups did not happen to the extent initially planned. Therefore, one of the main opportunities for peer learning was lost. The students valued working in small groups to build confidence and consolidate the scientific content.

All the staff interviewed were aware of the buskers. They were positive about the intervention saying that pupils were enthusiastic about their involvement and benefitted from the activities. They also thought that the buskers were good role models and highlighted that they showed people who liked physics were the same as everyone else. They said that the students had gained some science knowledge and skills, and developed confidence in presentation and explanation.

One thing that helped me was...

“Working in smaller groups so that I can build my confidence up before performing in front of a big audience.

A worry I still have...

“I am worried people are not interested in what I am saying. I can't talk in front of people.

3.2. Impact of activities working with parents

3.2.1. Postcards home

Only four forms were returned (less than 1% of the 338 posted) so the activity clearly did not engage the parents. A straw poll of pupils suggested that some did the activity but didn't return the form, some thought that the activity was babyish and gave it to a younger sibling and some threw it away. We conclude that attempts to reach parents in this manner, without adequate preparation, are unlikely to succeed.

3.2.2. Routes through Education events

The events alongside the options evenings worked well as parents and pupils were already thinking about their future. The event alongside the personalised learning day (PLD) was not as successful; although large numbers of families came to the school, many of them did not come into the Routes through Education exhibition. See table 3 for a summary.

The KS4 options and post-16 events were run alongside informative talks given by the school and these were perceived by staff as being very successful. They reported a good “buzz” about the place. These events were a new experience for the school and several members of staff commented that these events needed to be something the school did more of.

Many of the exhibitors were experienced in visiting schools and commented on how reluctant the pupils and parents were to engage with them. Out of 32 exhibitors, over half thought that the events went very well, a third thought that they were OK and four exhibitors though that the events had not been very successful. These four exhibitors commented that the events were well organised but that engagement with the families had not gone well. From observing the event, exhibitors that brought hands-on activities and pieces of equipment were busier than stands that brought paper-based activities, quizzes and computer-based activities (unless computers were being used for a very specific purpose, e.g. looking up apprenticeships).

Exhibitors also confirmed our initial impression that there is a lack of understanding about different careers and the routes to get there – pupils asked them about grades, qualifications and the different routes to get into different careers. Many exhibitors commented on the general lack of awareness about careers in their field (including law, engineering, apprenticeships and medical physics). On the whole, the exhibitors were a fantastic resource and tried really hard to engage the families. They were understanding of the project and that this was a new venture for the school, offering valuable suggestions for improving future events.

Despite offering a prize draw for filling in a simple feedback form, it was very difficult to collect feedback from parents. Less than 20% of families that visited filled in the feedback forms. Those received were very positive. When asked about which stands they learned the most at, the majority of parents indicated that the science-themed stands were most informative.

To become a recognised part of the school calendar, these events require improved marketing to both parents and students including clear statements of their purpose as part of an integrated programme of careers advice. Running them alongside existing options evenings worked well as long as they were promoted to families both before and during the evenings.

Staff spoke very positively about the Routes through Education events in the focus groups. They were seen as successful, especially the post-16 event. Staff present observed that families from a range of backgrounds were seen engaging with exhibitors.

3.3. Attitudes to science and physics

At the start of the project, an online questionnaire was completed by 7–11% of students across year groups 7–10. Science, English and maths were the most popular choices for potential A-level – similar results have been seen in larger surveys[11]. There was evidence of pupils not understanding how many subjects are usually studied post-16. This was more pronounced in KS3 but still evident in KS4.

Students generally have a positive attitude towards science in school and in general. 98% of students enjoy practical activities in science and 91% think that they are good at it, even though over a third think that science lessons are hard. 91% find science lessons interesting with 74% looking forward to science lessons. These figures indicate that, whatever barriers there are to students taking science subjects post-16, they do not include either a lack of interest or engagement with the subjects.

[11] *Good Timing – Implementing STEM Careers Strategy in Secondary Schools: Final Report of the STEM Careers Awareness Timeline Pilot* by Peter Finegold, Peter Stagg and Jo Hutchinson, November 2011. Published by the Centre for Education and Industry, University of Warwick **www.devonebp.org.uk/uploads/good_timing_stem_careers_2.pdf**

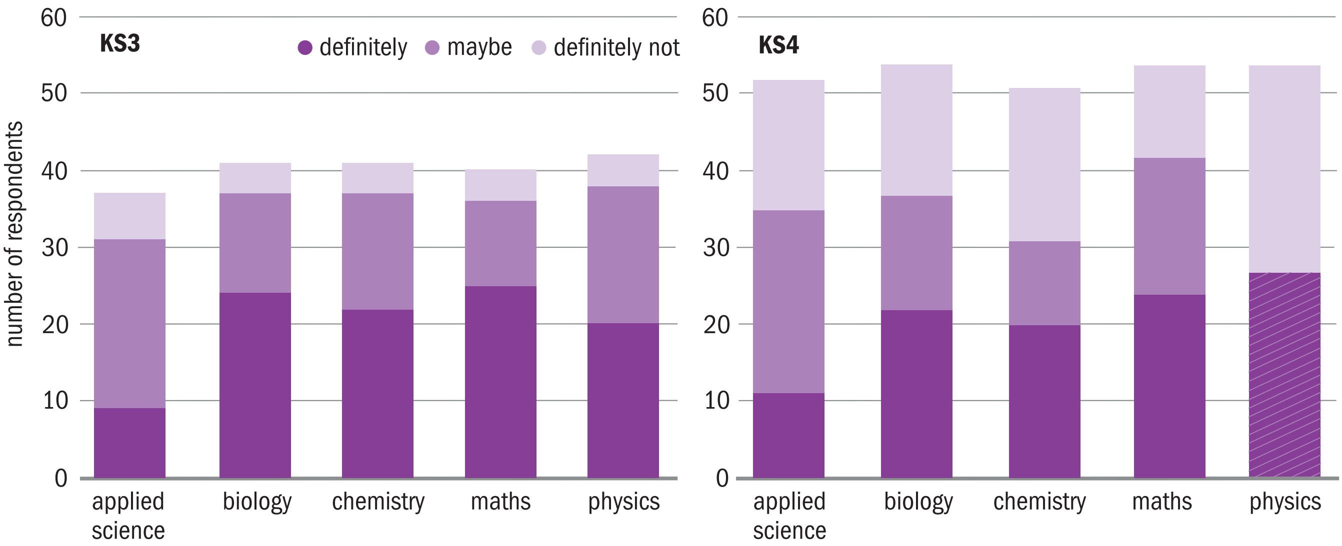
Table 3: Routes through Education events

	KS4 options event	PLD event	Post-16 event
Tally count*	140 family groups (estimate) 362 pupils and parents	119 family groups	151 family groups
Total attendance for the day (% of visitors to exhibition)	245 (57%)	1166 (10%)	162 (93%)
Prize draw form entered	28	38	11
Parent questionnaires completed	18	9	6
Visitors to stands	13–53 family groups (average = 22)	6–34 family groups** (average = 21)	8–35 family groups (average = 17)
Dwell time at stands	2–15 minutes (average 4.5 minutes)	1–15 minutes (average 4.5 minutes)	1–15 minutes (average 6 minutes)

*Note: at the KS4 options event pupils and parents were counted, whereas at the PLD and post-16 event family groups were counted (i.e. pupil and parent(s) counted as 1).

**Some stands could not stay for the whole events – these reported lower numbers of visitors.

Figure 4: Science and maths AS/A-level aspirations in KS3 and KS4 baseline surveys



Note: For the KS4 survey, students were asked if they were thinking of taking physics as a separate question (as the answer given led to different follow-up questions). 27 students said "definitely or maybe" shown as hashing on the graph. This is lower than the numbers who are considering (definitely or maybe) taking the other science subjects.

3.4. Educational aspirations and subject choices

In baseline surveys, students and parents were in general agreement about what the students should do post-16 with most students (~55%) and parents (60%) seeing A-levels as their preferred option. A sizeable proportion of pupils (15%) didn't know what they wanted to do post-16.

Previous research suggests that expectations regarding higher education are high at age 14 and "collapse" between the ages of 14–16 particularly among students from the poorest backgrounds (Goodman and Gregg, 2010[12]). This was also evident in the baseline surveys; there was a decline in those wanting to go to university as they progressed through the school.

In KS4, the majority (30/49) of students who were considering taking science and maths A-levels were considering taking 3–4 science/maths subjects.

Interestingly, the "definitely" aspirations for the three sciences are not dissimilar. Biology is slightly more popular than the other sciences. In reality, the numbers choosing chemistry and physics post-16 are much lower than the aspirations suggest and the numbers doing applied science are more than twice as large. Even in this small sample, there are more than 35 students at KS3 who are considering to study physics post-16, but these aspirations are not fulfilled, as only about a third of this number will go onto to study physics in year 12 and even fewer in year 13. In focus groups, about a quarter of the year 9 students were planning to take science subjects post-16, the majority of whom were taking triple science at GCSE. Six (22%) of the triple science students interviewed were thinking about taking physics post-16.

When asked where they obtained careers information, parents, teachers and family members are mentioned by most pupils that responded. These results are similar to those seen in The Timeline Project[13].

3.5. Parents' aspirations

Many parents (38%) had high aspirations for their child's future career in that they chose future jobs that require a degree (level 1 and 2[14]). A further 32% described jobs that require a high level of vocational degree and training (level 3). About 42% of parents described level 5 or 6 jobs that require a good level of education but no further qualifications after leaving school. Only 2% of parents specified low-skilled jobs requiring only a general level of education[15]. Parents thought that English, maths and sciences were the most useful subjects for getting a job. In the initial survey and during some events, it was evident that there is some confusion about options post-16.

[12] *Poorer children's educational attainment: how important are attitudes and behaviour?* by Alissa Goodman and Paul Gregg, Joseph Rowntree Foundation, 2010

[13] *Good Timing – Implementing STEM Careers Strategy in Secondary Schools: Final Report of the STEM Careers Awareness Timeline Pilot* by Peter Finegold, Peter Stagg and Jo Hutchinson, November 2011. Published by the Centre for Education and Industry, University of Warwick **www.devonebp.org.uk/uploads/good_timing_stem_careers_2.pdf**

[14] As classified by the SOC2010 index **www.ons.gov.uk/ons/guide-method/classifications/current-standard-classifications/soc2010/soc2010-volume-1-structure-and-descriptions-of-unit-groups/index.html**

[15] Some parents put more than one answer down so the percentages add up to greater than 100

3.6. Staff attitudes towards interventions

Staff in the science department were asked to fill in a short survey at the start and end of the project. At the start of the project, staff were overwhelmingly positive about taking part in the project and attending CPD sessions. Suggestions that the teachers made for encouraging more pupils to take physics included offering enrichment and practical activities, providing staff CPD, careers advice and positive role models and speakers. They thought that prior attainment was the biggest barrier stopping pupils from taking physics.

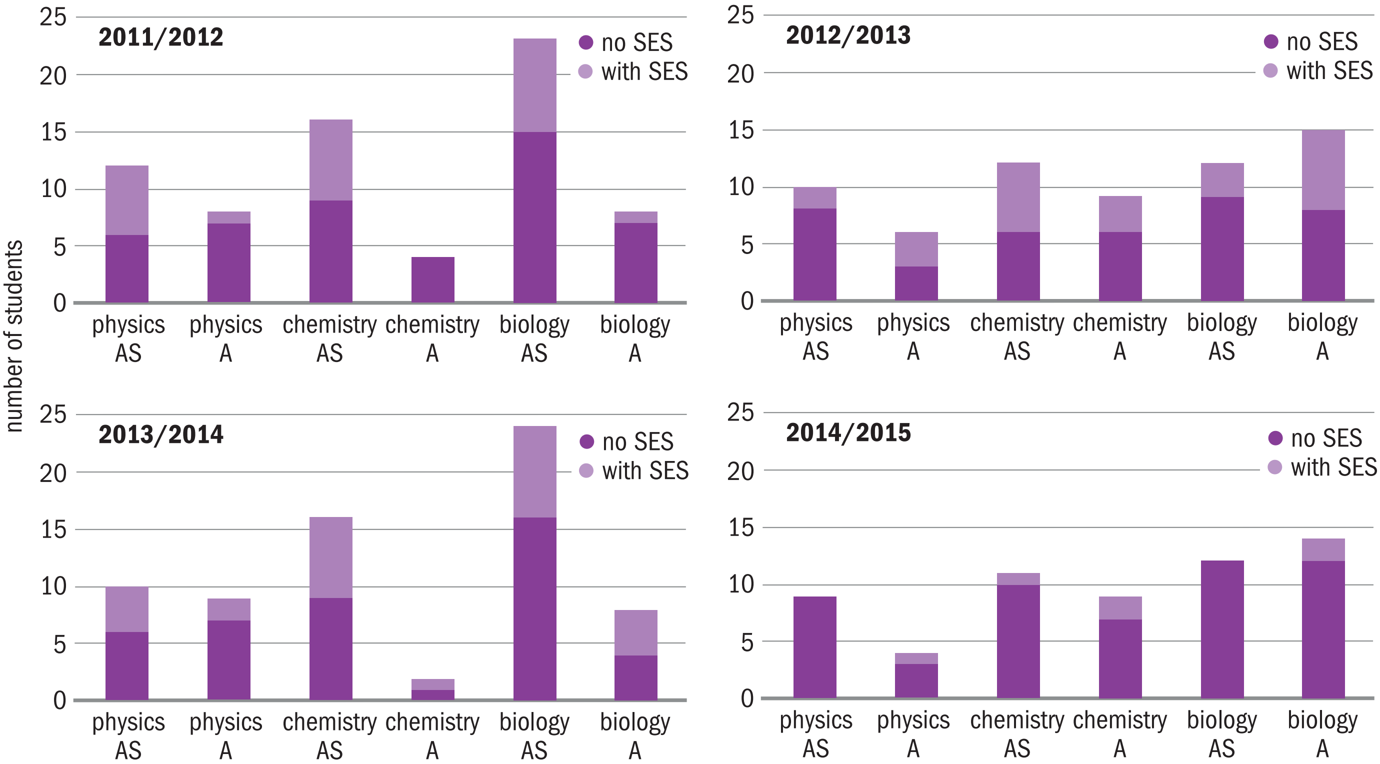
In 2011/12, most of the staff enjoyed teaching physics (n=16) but fewer felt confident about teaching physics (n=13). Less than half thought that their physics knowledge was up to date. At the end of the project, more than half of the staff did think that their physics knowledge was up to date.

The end of project survey showed that the CPD sessions were all rated as useful or really useful by the staff. The final two sessions on feedback and "growth mindsets" had particularly positive responses. This may be partly because they were fresh in people's memories and that they would have been attended by all the current staff, whereas new teaching staff had not attended the earlier sessions. One teacher commented on this and suggested a recap on the earlier topics would be useful. Over half (8/13) of the staff said that they had used the CPD sessions in their classrooms and a further three said that they hadn't yet but were planning to in the future. Most of them said that they had used strategies from the feedback sessions in their lessons and one had used practical activities (this was on the recommendation of the technician who also attended the CPD).

When asked about the impact of the project, the teachers said that the project had improved their teaching of physics, that the students who took part in the project had a more positive attitude towards physics and that they had more information about post-16 and future career options.

3.7. A-level numbers in the school

Figure 5: Numbers of students, with and without SES indicators, studying AS- and A-level sciences in the years of the project



4

Discussion

4.1. Impact of interventions on aspirations

The one-off interventions were well received at the time but their impact diminished as the time from the event increased. The interventions with the biggest impact were the activities that lasted longer than one day, namely the Extreme Physics residential camps and the physics busking, as well as the CPD sessions with staff.

There are fluctuations in the total numbers of pupils that take A-level sciences and the number of pupils with SES indicators that take them (see figure 5, p15). It is difficult to see if the interventions have had any impact here. The AS-level students in 2014/15 were the first cohort to have taken part in the project. There was no increase in the numbers of pupils taking physics at AS-level in this year and no pupils with SES indicators were taking it. However, the proportion of pupils with low SES had dropped across all three of the sciences in 2014/15.

The focus groups showed that students with specific career plans tended not to change their mind, whereas those that had vague career plans in year 9 had changed their minds. One pupil in the focus group reported that the interventions had encouraged them to take physics post-16; others planning to take physics were already intending to in year 9. The focus groups also revealed that strong future career plans were important to those students who want to take science post-16. Students with specific career aspirations (e.g. vet, doctor or other medical-related jobs) had a greater understanding of the need to take appropriate A-levels to get to university.

Of the pupils attending *Extreme Physics* who have now reached the sixth-form, two out of eight started AS-level physics. Although numbers are small, considering the numbers taking AS-level physics as a whole, this is a positive sign, especially as these were both female. The student now in year 13 has dropped physics at A-level, but it may be worth noting that had she continued she would have been the only girl in the class.

Staff and pupils thought that the physics busking improved self-confidence and presentation skills of the pupils that took part and the pupils enjoyed it. To increase the impact of this intervention, inviting larger numbers of SES pupils to take part initially before opening up the opportunity to other students would be a good strategy. It is important to find a regular time slot to work with physics buskers that is accessible for different year groups.

4.1.1. Deciding to take physics post-16

One girl who had taken part in many interventions wanted to be an English teacher in year 9 but had changed her mind and now wanted to take physics at A-level and study science at university. She cited several influences that changed her mind: friends, family, teachers, enjoyment of subject, attainment and being involved in science activities outside of lessons.

A boy who was not directly involved in the project who had changed his mind to take physics post-16 said knowing about careers was the most important factor in making his decision.

4.1.2. Deciding not to take physics post-16

Reasons given by those who had dropped physics from their plans in year 11 included:

- A change in teacher and topics that they disliked
- Struggling with physics and chemistry, and planning to do engineering BTEC instead
- One wanted to leave school and get a job
- A-level sciences are too hard

Lessons learned

5.1. Students' lack of self-confidence

A lack of student self-confidence was evident in many of the interventions especially during presentations. As the entry requirements are high and physics is perceived to be a difficult subject, a lack of self-confidence may have a bigger impact on choosing to study physics compared with most other subjects.

The researchers from the *(In)visible Witnesses* project found that the lack of confidence of the students hindered their ability to present their ideas to their peers. The researchers had carried out similar activities in many other schools and had not observed this lack of confidence to anything like the same extent.

5.2. Lack of careers knowledge among parents and students

A lack of knowledge and understanding about different career paths was evident in the parent surveys, pupil surveys and the focus groups. For example, there were children who had specific career aspirations e.g. nurse, PE teacher, doctor, but were not planning appropriate routes after year 11 to get into those careers and did not realise that they would need A-levels to pursue them.

The focus groups demonstrated that many students in years 9, 10 and 11 had confused ideas about what they want to do in the future and/or were not aware of how to get there, notably in terms of making choices about subjects within school at post-16 and how to get to university or into apprenticeships. Those pupils who had firm ideas of what to do had a better understanding of the need to take appropriate A-levels to get into university. Those pupils with vague and often diverse career plans did not understand what qualifications were needed and whether or not they needed to go to university (or even study A-levels) to enter some of them

These students would benefit most from targeted career information and advice about facilitating subjects to study at A-level. As most pupils get careers advice from their parents (or other family members) information needs to be given to parents as well as the students.

About half the teachers in the science department however thought that students in year 11 had good awareness of options and career choices when choosing A-level subjects. This does not seem to be true of the majority of pupils involved in the evaluation. Links to careers in lessons and in any enrichment activities need to be more explicit.

5.3. Post-16 option choices

The school requires a grade B or above at GCSE to get into A-level biology or chemistry but a grade A or above to get into physics A-level. The higher grade requirement for physics A-level exacerbates the issue of prior attainment reducing the pool of pupils from lower SES backgrounds able to take physics. Most of the lower SES pupils are found in the single- and dual-science GCSE groups which, in practice, give them little opportunity to enter the A-level sciences, particularly physics. It also strongly reinforces the notion that physics is more difficult than other subjects, which has a detrimental effect on students with low self-confidence.

Timetabling restrictions at the school mean that AS-level physics cannot currently be taken alongside PE, or psychology (among others). For students interested in doing sport or psychology (which is particularly popular with girls), this restriction may result in them not taking physics. Timetabling issues are not unique to this school and may often be a factor in decision-making at both KS4 and post-16.

There appears to be a collapse in aspirations in terms of the number of pupils considering studying physics (and chemistry) compared to those who actually do choose it. This is not the case with biology and for applied science the opposite is true. GCSE grades actually achieved are likely to have an impact on final choice. The entry requirements for applied science are much lower (five GCSEs at grade C including English, maths and science) and it is, therefore, more accessible.

For pupils who took part in the focus groups, the decrease in the numbers of students from low SES backgrounds planning on taking post-16 science between year 9 and year 11 was noticeably larger than those from other SES backgrounds.

5.4. Engagement and pressures on schools

As an external organisation, it is a straightforward exercise to design a set of interventions with different populations of a school community. In reality however, when working with a school, there are other factors and considerations that mean it is not always possible to work with the planned target groups.

Schools are under enormous pressure to achieve on performance indicators such as Ofsted inspections and national league tables. Therefore any school has a large number of actions to prioritise, as well as a large number of external pressures to deal with. Over three years, the project partnership faced the following challenges:

- School conversion to an academy
- Restructuring at senior management levels (including three different heads of science)
- A number of course changes within the science department
- Several instances of extreme weather in winter 2012/13
- Strike action
- Staff changes in the physics/science department
- Ofsted inspection

All of these pressures had an impact on planned activities and access to staff and students.

Policy changes such as the introduction of the EBacc[16] had a large impact on the science courses offered at KS4. More students are now taking dual and triple science, however, the proportion of students with one or more SES markers has increased in the core science (GCSE science), leaving more pupils without SES markers in the dual and triple science groups.

5.5. Working with staff effectively

In order to maximise the impact of staff CPD, the link between the individual sessions and how they fitted into to the project needed to be made more explicit. Including new strategies into schemes of work is necessary for them to become integrated into teaching practice.

Partnering with the Gifted and Talented co-ordinator, who had the experience of arranging to take pupils out of school, enabled the physics buskers to have a more enriching experience.

The project relied heavily on individual members of staff for activities, such as the Routes through Education events, to be carried out effectively. Spreading this load would have decreased the burden on individual staff members and increased potential for sustainability. For new initiatives to continue they need to be incorporated into the school calendar and have commitment at a senior management level.

[16] The English Baccalaureate (EBacc) is a measure of how many pupils achieve a grade C or above across a core of academic subjects. More information is available at **www.gov.uk/english-baccalaureate-information-for-schools**

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Charity registration number 293851
Scottish Charity Register number SC040092

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