Action Research for Physics Programme

Final Report

May 2011

Executive summary

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This report is an evaluation of the *Action Research for Physics* (ARP) programme which was organised and managed by the National Network of Science Learning Centres and led by *Myscience* between September 2009 and February 2011. The research was commissioned by the National Network of Science Learning Centres and Department for Children, Schools and Families. The ARP programme was largely based on the findings and recommendations of the *Girls into Physics* project (Daly et al., 2009). It is a model of professional development incorporating action research, with an aim to trying out new approaches to teaching physics which lead to an increase in young people's engagement with the subject, and pursuit of physics beyond GCSE level.

The main aims of the evaluation were:

1. To examine the effectiveness of the programme in changing pupils' attitudes to physics;
2. To document and categorise the nature of effective practice across the action research case studies.

To this end, instruments were designed to assess i) pupils' attitudes to physics before, during and after the programme, ii) pupils' aspirations for further studies, and iii) classroom practice of participating teachers. The nature of effective practice across the action research case studies was documented and categorised using teachers' reports on their action research interventions and outcomes. Data was collected from: four pupil questionnaires (three given to the study groups before, during and after the intervention, and one given to a 'control' group the year above the study groups at the start of the intervention); pupil focus group meetings (before and after the intervention); two teacher questionnaires (before and after the intervention); teacher focus group meetings (after the intervention); interviews with the teachers' senior managers (after the intervention); and interviews with the ARP course tutors (after the intervention). 67 teachers took part in the physics action research projects in a range of schools, and data was collected and analysed from their pupils and senior managers, amounting to almost five thousand individuals in total.

The Action Research for Physics Programme seems on the whole to have been a very positive experience for teachers and course tutors, and a number of important positive effects on pupils emerged from the statistical analysis. The main effects were in pupil engagement and interest in physics, the amount of discussion time in physics, pupils' intentions to take up physics post-16, and pupils' awareness of physics-related careers. The vast majority of teachers and senior managers viewed the programme as a resounding success for the teachers themselves, their pupils, their departments and their schools, and they intend to continue with this action research approach to teaching physics as a means of improving classroom practice. Teachers reported that often girls responded especially well to the changes they made in classes, and that the girls became much more 'visible' and 'audible' to the teachers (i.e. they were less overshadowed by the boys), and therefore their abilities became clearer. Teachers also reported more enthusiasm, interest and confidence in teaching physics. They indicated that contextualising physics, making it relevant for pupils and linking it with careers are now much more often in the back of their minds when they teach physics. The feedback from all stakeholders clearly indicates that the ARP programme should continue, albeit in a slightly modified form, and there is a very real need to track the teachers who took part in this round of the programme, to see what impact their teaching has had on post-16 uptake of physics.

Key findings

1. The following main points emerged from the pre-intervention pupil questionnaire:

- Pupils were significantly more interested in physics when they felt their lessons were aimed at their own gender. However, surprisingly girls felt significantly more often that their lessons were aimed more at girls when they had a male teacher.
- Pupils found physics significantly more difficult when they felt that there was not enough time to think or discuss things in physics lessons. Boys more often than girls expressed a need for more discussion time in physics lessons; and girls more often than boys expressed a need for more thinking time.
- Pupils were significantly more interested in physics when they had experienced careers talks in relation to physics.
- Pupils were significantly more interested in physics when their physics lessons were linked to their daily lives, to worldwide issues, or to other curriculum subjects.
- Physics topics most often cited as particularly interesting were the solar system and universe (astronomy), forces, and electricity. However, forces and electricity were also most often cited as the least interesting topics (together with energy).

2. The most striking results of the pre-intervention teacher questionnaire were:

- 90% said that they 'rarely' differentiated for boys and girls; and only 24.5% reported that they 'often' differentiated for gifted & talented pupils (68.2% did this 'sometimes').
- 25.5% 'never' linked physics with careers in their physics lessons.
- 28.2% of teachers reported that they 'often' made links with global and social issues in their physics lessons; 56.4% did this 'sometimes'.
- Teachers concerns about teaching physics were concentrated in the areas of i) engaging and enthusing pupils, ii) making physics relevant, iii) challenging pupils' perceptions of physics as a hard subject, iv) progression to post-16, v) confidence in their own teaching of physics, and vi) gender imbalances (particularly girls' enjoyment of and potential progression with physics). They felt that increasing the relevance of physics to everyday life, using contexts, and making lessons more engaging, were all needed more in physics classes.

3. Statistical linking of the pre-intervention pupil and teacher questionnaires found:

- A significant positive relationship between pupils' interest in physics and how often teachers report that they link physics with everyday life.
- A significant negative relationship between pupils' interest in physics and how often teachers encouraged dialogue between pupils and themselves.
- A very strong positive correlation between how often teachers claimed to link their physics lessons with everyday life, and how often pupils felt that this was happening. This is an important and meaningful finding as it seems to show that pupils clearly picked up on what teachers were doing in this area.
- Interestingly, pupils did not find physics easier or more interesting when their teacher had a physics degree.

4. Comparing pupils' responses in all three questionnaires (pre, mid and post-intervention), the most distinct areas of change were:

- Pupils' intentions to study physics post-16 significantly increased.
- Pupils reported significantly more careers talks; this was sustained until the end of the project.
- A significant increase in links made to worldwide issues in lessons; this was sustained until the end of the project.
- Pupils report significantly more time for discussion.
- However, pupils reported that their interest in physics fluctuated throughout the programme (down after the first session of action research of their teachers, up again at the end of the programme but not significantly higher than at the beginning).

5. When the final pupil questionnaire responses were compared to the 'control' group of pupils, the following statistically significant differences emerged. For the intervention groups, there was

- An increase in pupil interest in physics.
- A reduced level of experienced difficulty with physics (e.g. difficulty with words and terms).
- An increase in reported time for reflection in physics lessons.
- An increase in the likelihood for Post-16 physics uptake.

- A higher reported number of careers talks in physics, especially by science teachers.

6. The post-intervention teacher questionnaire found that:
   - 98.5% of participant teachers felt positive about taking part in the ARP programme.
   - 95% of teachers felt that their participation in the programme had been effective in increasing their pupils' engagement with physics.
   - 64% of teachers indicated that they felt an increased motivation/enthusiasm to teach physics since they started the programme, and 50% of the teachers said that their own interest in teaching physics had increased since they started the programme (for the remaining 50% their interest had stayed the same).
   - 90.6% of teachers thought they had learnt 'quite a lot' or 'a lot' about action research since starting the programme.
   - 100% of teachers found action research useful in terms of improving classroom practice.
   - 86% of the teachers said that they have made changes to their classes as a result of the programme.
   - 72% of teachers had increased discussion time over the course of the programme.
   - 57.8% of teachers increased reflection time.
   - 50% had changed their schemes of work as a result of the programme.
   - Teachers' confidence increased most in their ability to make physics relevant, to get pupils engaged in physics, to increase pupils' awareness of careers/futures in physics, and to make abstract physics more 'visible' for pupils.
   - At the end of the programme, the participating teachers significantly more often used gender-neutral examples in their physics lessons, and increased links between physics and other subjects.

7. The impact of teachers' action research interventions was strongest in the *Teaching and Learning* research strand, both according to the teachers themselves and their senior managers. According to the senior managers, the *Teaching and Learning* interventions had a significantly higher impact on pupil attitudes to physics, pupil learning, and post-16 uptake of physics.

8. Teachers' reported that their interventions had the following impacts *outside* their own classes:
   - 39% of teachers said their colleagues were interested in their new approach to teaching physics and were adopting these in their own lessons.
   - 22% of teachers indicated that their Head of Department was using their new approaches to teaching physics for adoption throughout the department.
   - 31% of teachers reported that changes in the way they teach physics are/will be discussed or implemented on a wider school level.
   - 11% of teachers indicated that changes in the way they teach physics are/will be discussed with or implemented in other schools they work with.

9. 92% of the senior managers felt that action research was useful for classroom improvement (47.4% felt it was 'very useful' and 44.4% felt it was 'quite useful'). Over a third said they had plans about using their teachers' findings in future staff

development. Almost two-thirds said they would send other teachers on the course in the future, and 87% would recommend the course to other senior managers.

10. There was a positive correlation between the extent to which senior managers felt that the teacher's participation has impacted on pupil learning, and the self-reported likelihood of pupils to take physics post-16.

11. Main findings from the final teacher focus group meetings were:

- The most useful aspects of the ARP programme were meeting and sharing ideas with other teachers; taking time out of school to reflect on teaching; having the chance to focus on/ study one particular aspect of one's teaching and following it through rigorously; unexpected (and informative) outcomes of pupil surveys and interviews.
- Least useful aspects were the short time span and the timing of the course; a need for more (and earlier) one-to-one support.
- The most frequently mentioned effects on pupils were increased engagement, enthusiasm and more positive attitudes towards physics, a better knowledge of what physicists do, information about physics careers, and improved confidence.
- Major reported effects of the action research projects on teachers were: more reflection about the relevance of physics; building in the context; valuing pupils' opinions more; more confidence and enjoyment in teaching physics.
- The projects would be continued with other groups and by other teachers, and there was more sharing of ideas within the department.
- Many positive effects (especially on girls) were reported.
- Discussion had become a more natural part of their physics lessons. Thinking time had sometimes increased.
- Very positive views were expressed on the usefulness of action research; there was increased confidence to go back to something that hadn't previously worked, reflect on it and improve it, whereas before teachers were often inclined to just move on and try something else if something didn't work with their pupils.
- Not many teachers had hard evidence for an (intended) increase in post-16 take-up yet, but there was often a sense that it might increase, taking pupils' enthusiasm and comments as indications. Some teachers reported that pupils, especially girls, had changed their minds positively towards physics.

12. The main findings from the interviews with ARP programme tutors were:

- Participants appreciated and made good use of having the time out of school, and having a long period of time to reflect on their practice and to implement something in their classes. The process of action research was perceived to have inspired participating teachers and course tutors felt that there had been an impact in the classroom.
- The course content was generally seen as appropriate, although some tutors wondered if more time should have been spent on action research, with case studies and examples, or even whether the focus should have been on action research only.
- Only one SLC was able to start on time. For the rest, the first CPD session was in the middle or late part of the autumn term, resulting in teachers having to work across two academic years with different classes. Many

course tutors also wanted a follow up session with participants around 6 months later, to properly complete the cycle of the programme with the teachers.

- Communication via the portal was an issue – all SLCs reported that this was unsuccessful and that new strategies to encourage this in the future should be developed. However, in almost all SLCs, a real community came into being amongst the course delegates and many kept in contact with each other between sessions.
- Communication between course tutors and programme leaders about the course, before and throughout, was also seen as something to improve the next time to achieve better joint planning.
- The action research element was seen as something that could be a very strong marketing point for the SLC network as one of their specialisms.
- Course tutors were somewhat frustrated at not knowing the real effects of the teachers' action research projects, as there was no opportunity to observe teachers' classes, and they had to rely on the teacher presentations during CPD sessions.
- Many teachers reported positive effects of their interventions on girls, even when these had not been specifically targeted at girls. However, one course tutor felt that gender issues had not been tackled explicitly enough in the course and that many gender issues could still be found amongst delegates with regard to their views on boys and girls studying physics.

Recommendations

- The ARP programme has been a resounding success, despite some small teething problems. It is therefore recommended that the programme continues in the light of the considerable experience gained so far by all its contributors.
- In line with the feedback from course tutors and participating teachers, the first CPD session should be held in the summer term, enabling teachers to plan ahead properly and start their interventions at the beginning of the autumn term with the same classes for a whole academic year.
- If an on-line component is deemed important by the SLC network, more joint planning and determination among centres would be required to ensure its success. However, the lack of enthusiasm for the online-facility among this group of participating teachers indicates that it might reduce course satisfaction, if not implemented appropriately.
- If possible, it would be very useful for course tutors to visit some of their teacher participants at school to see them teaching. This would help the tutor see the impact of their training, and provide the teachers with additional mentoring opportunity.
- Many course tutors expressed a wish to focus more on action research in future sessions, and some common guidance would be helpful for consistency of delivery of this aspect. Action research could be developed further as a Science Learning Centre Network specialism and promoted as such.
- There is a very real need to track the teachers who took part in this round of the ARP programme, to see what lasting impact their action research approaches are having on their classes. Such tracking would also help ascertain post-16 physics uptake resulting from the implementation of the ARP programme.

Final Report

Evaluation of Action Research for Physics Programme

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1 Introduction

There is widespread concern in the UK about the national shortage of physicists due to a shortage of pupils opting to study physics at school, and hence at university. During 2007/08 the National Network of Science Learning Centres carried out the *Girls into Physics* professional development programme for teachers of physics, which encouraged the participants to explore fresh ways of teaching physics with a view to attracting more girls to engage with physics learning and hopefully to continue with their studies. Results from the evaluation report (Daley et al., 2009) suggest that many teachers were encouraged by the response from the girls in their classes, and in keeping with the findings of an earlier research activity by the Institute of Physics (Grant et al., 2010) the boys were also attracted by the new approaches to teaching and learning.

In 2009 this programme was extended in the form of the *Action Research for Physics* (ARP) programme. Using a similar model of professional development incorporating action research, the aim was to extend the scope of the proposal to cover how new approaches to teaching physics lead to an increase in young people's engagement with the subject, and pursuit of physics beyond GCSE level. The authors of this report have been involved in evaluating the success of the programme.

The aims of the evaluation were:

1. To examine the effectiveness of the programme in changing pupils' attitudes to physics;
2. To document and categorise the nature of effective practice across the action research case studies.

To this end, instruments were designed to assess i) pupils' attitudes to physics before, during and after the programme, ii) pupils' aspirations for further studies, and iii) classroom practice of participating teachers. The nature of effective practice across the action research case studies was documented and categorised using teachers' reports on their action research interventions and outcomes.

The professional development programme consisted of three separate one-day training sessions at Science Learning Centres across England, focusing on action research theory and explanation, classroom strategies, and feedback from individual teacher's action research findings. Teachers conducted two rounds of action research between the professional development sessions, in one of six prescribed strands identified as areas of good practice in the *Girls into Physics Project*: Learning and Teaching; Classroom Management; Careers; Progression; Workforce; Culture and Ethos.

The *Girls into Physics: Action Research report* (Daley et al., 2009) indicated that teachers felt bombarded with ideas, guides and policies about how to get more girls interested in physics. Teachers found that the key to a successful project was to start by understanding the context in their own classroom, department or school, and to identify small changes that they had the power to implement and understand. Action research is about positioning the teacher as the agent of change in the situation, and the *Action Research for Physics Programme* was designed to explore further ways for individual schools to support physics pre and post-16.

2 Methodology and Timeline

From September 2009 to February 2011, the nine regional Science Learning Centres (SLCs) each held three professional development (CPD) days for the ARP programme. The National Science Learning Centre held the first part of its course "Success in Teaching Physics 11-16 for Specialists" in June 2010, which overlaps in a number of areas with the ARP Programme (e.g. the focus on 'Girls into Physics', and the action research element).

Table 1. Timeline of research activities

Autumn 09	**First professional development session**
	Teacher questionnaire 1 (pre-intervention)
	Pupil questionnaire 1 (pre-intervention)
	Pupil focus groups (pre-intervention)
Spring 10	Pupil questionnaire for Year group (control group) a year above the intervention groups
Summer 10 - Autumn 10	Pupil questionnaire 2 (mid-intervention)
Summer 10 - Autumn 10	**Second professional development session**
Autumn 10- Winter 11	**Third professional development session**
	Teacher questionnaire 2 (post-intervention)
	Teacher focus groups (post-intervention)
Autumn 10	Pupil questionnaire 3 (post-intervention)
Winter 11	Questionnaires for senior managers (post-intervention)
Winter 11	Pupil focus groups 2 (post-intervention)
Dec 10 – Feb 11	CPD tutor interviews (post-intervention)

The first day of the ARP programme generally consisted of an overview of the outcomes of the *Girls into Physics* project (IOP, 2007), an outline of what action research is, and a brainstorm about topics that could be researched by delegates at their schools, although there was slight variety between SLCs. On the first day, teachers at all SLCs, including the National SLC, were also informed about the evaluation research and completed a baseline online Teacher Questionnaire. The agreed process at most SLCs was that, prior to the second CPD session, teachers would agree their action research topic, and start with a first round of data gathering and action research with their chosen group of pupils (this was to be a year 8, 9, or 10 group).

A baseline Pupil Questionnaire (in hardcopy) was then distributed to course participants as soon as their contact details were obtained from the SLCs after their first CPD sessions, so the first baseline pupil questionnaire sets were sent out to teachers in October 2009 and the last in June 2010, after NSLC completed the first session of their course. The course delegates' senior managers were also informed at the same time about the evaluation of the programme, and asked to take part in a survey at the end of the programme about their views of the impact/effect of the programme.

Meanwhile, teacher participants were approached with an invitation for two groups of six of their pupils (one consisting of gifted & talented pupils and the other of a cross-section of pupils) to take part in pupil focus group meetings, for the purpose of data triangulation with the baseline pupil questionnaires. The aim was to gather data this way from one school in each of five SLC regions. 13 focus group meetings have taken place for this purpose. The participating teachers have been most helpful and organised setting this up for the researchers.

Teachers who returned the baseline pupil questionnaire were also asked to administer the same questionnaire to a year group directly above the intervention group. This group was to be as similar as possible to the intervention group in ability level. These pupil groups functioned as 'control' groups to the pupil groups who filled in the baseline questionnaire.

In March 2010, CPD course leaders and SLC directors met at the IOP in London to evaluate the first CPD sessions and discuss the second sessions. The evaluation researchers were also present at this meeting. Interim results of the baseline pupil and teacher questionnaires were presented by the researchers and these were sent to CPD course leaders for their use during the second CPD sessions.

The second CPD day was generally used for teacher delegates to present the findings of their first round of action research and to feed back to each other. At some SLCs, some Teaching & Learning CPD was undertaken as well. In one SLC, there was an outside specialist speaker on action research who held a talk. The evaluators were invited to three SLCs to present the interim findings of the evaluation to the course delegates during these sessions. This seemed to be received well and often resulted in lively discussion amongst the participants. The researchers attended these course days to get an impression of the course activities, and gain further insight into the kind of projects delegates were undertaking. The other SLCs were issued with supportive materials to inform participants about the evaluation.

In early June 2010, a second (interim) pupil questionnaire was sent to the teachers who had returned the baseline pupil questionnaire, followed by reminders at set points. This pupil questionnaire was almost identical to the first one in order to objectively measure any changes in responses. However, two 'subjective' questions were added to the second questionnaire, asking pupils about whether they were more/less/equally interested in physics than before, and whether they found physics more/less/equally difficult than before.

After the 2010 summer break, reminders were sent out for teachers to return Pupil Questionnaire 2. In late October, the final pupil questionnaire sets (Pupil Questionnaire 3) were sent to the teachers trained at the SLCs having their final CPD day in November or early December. The teachers whose pupils had previously participated in focus group meetings, were contacted again to organise post-intervention pupil focus group meetings with the same groups of pupils. One SLC had initially scheduled their final CPD session in September 2010 but moved this to November to give teachers more time to finish with their action research interventions. Most other SLCs had their final CPD sessions scheduled for mid/late November and early December. Due to heavy snowfall in December, some of these had poor attendance or had to be cancelled and rescheduled. These rescheduled sessions took place in January. The handing in of their final action research reports by teachers was thereby also somewhat delayed. The National Science Learning Centre was one of the SLCs who had to postpone their final CPD session, and in their case this was rescheduled for March, and as such the researchers were not able to include them further in this evaluation research. Whilst some of their course delegates returned Pupil Questionnaire 1 and 3, we only have their baseline Teacher Questionnaires.

The follow-up pupil focus group meetings were held at five of the schools previously visited for this purpose. It turned out to be slightly more difficult to organise these again. Two of the schools participating in this were in a region where the SLC's final professional development session was in February, and therefore the focus group meetings had to be scheduled at the end of the programme to make sure they were after the teacher had finished their intervention, but this was too late to include in the evaluation research. In the five participating schools, it was not always possible to speak to all the same pupils again, and in two schools, the previously two separate groups were merged into one for number reasons. In one school however, this was the other way around: initially only one group had been interviewed, but upon coming back the teacher could organise two groups, of which one was of his intervention group and the other of a group he used as a 'control' group.

The third CPD sessions at the SLCs were mostly used for teachers' presentations of their action research interventions, final advice and support with report writing, discussion of findings and useful classroom strategies and comparing this to opinions/views at the start of the course, and the completion of the final teacher questionnaire (Teacher Questionnaire 2). This was to gauge the impact of the programme and teachers' experiences of participating in it. At the end of the third CPD sessions, the evaluators held a focus group meeting with volunteer teachers to triangulate the findings from the final teacher questionnaire. These focus group meetings were either held face-to-face at the SLCs, or by videoconference. The meetings were very informative.

After the final CPD sessions, the course tutors took part in a 30-minute phone interview to share their experiences of teaching the course, what they felt worked well and could be improved, what they felt was the impact of the course and the action research interventions on the participating teachers and their pupils/departments/schools. Senior CPD Managers of the participating teachers were also sent a questionnaire to gauge their impression of the successfulness of their teachers' participation in the programme.

Questions for all of the interviews and focus groups can be found in the appendices.

The following sections present final data analysis of the baseline, interim and final pupil questionnaires, the baseline and final teacher questionnaire, the CPD managers questionnaire, and the comparison between the final pupil questionnaire and the questionnaire that was administered to the control 'year above intervention' group in January 2010. A summary of findings of the pupil focus groups (baseline and final) conducted is also presented, as well as of the focus group meetings with participating teachers at the end of the course, and the post-course interviews with the course tutors. An overview will also be given of the types of action research projects the teachers have carried out.

Statistical analysis

Statistical analyses used were chi-square and t-tests for comparisons between subgroups of the sample (e.g.. girls and boys; students who find physics difficult to different degrees; students who aim to choose physics post-16 to varying degrees of likelihood). Independent sample t-tests were used for comparisons between responses made at different measuring points (i.e. pre-intervention, interim, and post-intervention measurement). Pearson correlations were used to explore links between variables. It is important to keep in mind with all the statistical relationships mentioned throughout this report, that they are simply correlations, and do not present cause and effect relationships. All significance levels mentioned are at the $p<.05$ level, unless otherwise stated. It also needs to be kept in mind that the teacher questionnaire data sample, with 110 participants for Teacher Questionnaire 1 and 64 for the Teacher Questionnaire 2, is not very large, so care needs to be taken when interpreting analysis of this data. This also applies to the findings of the Senior Managers Questionnaire.

First, an overview is given of the action research interventions the participating teachers undertook as part of the ARP programme.

3 Teachers' action research projects

Areas of practice and interventions

Teachers' action research interventions were distributed across the strands identified in the *Girls into Physics* project (Daly *et al*., 2009) as follows:

Learning & Teaching:	38 teachers
Classroom management:	1 teacher
Careers & Guidance:	19 teachers
Progression:	4 teachers
Workforce:	0 teachers
Culture & Ethos:	1 teacher
Combined areas:	9 teachers

The final reports about the interventions are presented in an overview in Appendix 2, presenting school context, research questions, intervention, outcomes, limitations, sustainability and the next steps the teacher intends to take from the research. Of the 67 received reports, 8 of the action research interventions were carried out in girls' schools, one in a boys' school, and the rest in mixed gender schools. 44 of the 67 schools involved have sixth forms, and one is a sixth form college only.

Teachers were asked to indicate their view of the level of change (or impact) resulting from the intervention. The reports have been classified according to these levels of change (i.e. no change, a little change, some change, major change), and within this categorisation, by the above strands. During interviews, the course tutors were asked for any results of the action research interventions of their teachers they found particularly interesting or surprising, and the projects they have mentioned are indicated in bold. Also, the projects for which the CPD managers of the teachers in school have indicated a particularly strong impact (as indicated by scores in the questions about 'impact' in the CPD Managers Questionnaire) are indicated in bold, as have the projects which the researchers felt were of particular interest.

As seen above, of the six strands, most projects were in the strands of *Careers & Guidance* and *Teaching & Learning*. Nine were in combined strands but again these were then often combined between these same two strands, or *Careers* combined with *Progression* for example.

Teachers' action research projects in the area of *Careers* and *Guidance* often consisted of the following activities:

- Getting outside speakers in (university professors, former students, both with high-profile, high-income jobs); for students as well as at options info evenings for parents
- Setting up physics clubs
- Letting students research careers and/or do presentations about what physicists do
- Posters/displays up in corridor/classrooms and regular updating of these

(These interventions did not always include activities within the classroom)

Interventions in the area of *Teaching and Learning* covered the following main areas:

- Questioning techniques
- Collaborative work / experimenting with single-gender/mixed-gender groups; groups according to level (single or mixed)
- Bringing in the context and applications at the beginning of a topic, rather than wrapping up with them at the end of a topic (seen as especially successful)
- Generally bringing in more real-life context into the lesson, for example small anecdotes
- More practical work
- Doing the maths first so that students can show they can do the calculations
- Working with concept maps
- Using Video peer assessment strategies
- Using more visual materials; use of more/new/creative/different materials (i.e. *You Tube* / using new equipment in practicals, funded by IMPACT award
- Bringing in more cutting edge/wow! physics and addressing "the big questions"
- Including more discussion
- Reducing textbook work
- Going outside the classroom more
- Bringing in cross-curricular activities/lesson plans

There was a wide variety of strategies used in teacher interventions and looking at the reports, it seems that teachers often tried to answer several big questions with their small and focused action research projects, which clearly could not all be answered within the scope of the projects.

To find out about issues experienced by students in physics classes, and to gauge the success of their interventions, the teachers often the evaluators' questionnaire, Teachers regularly commented on how eye-opening the student comments had been, either in the questionnaires or when teachers had interviewed their students or held focus group meetings with them.

One course tutor commented that the reports did not do justice to the richness of the projects and the findings, and the learning of the teachers and students. She felt the reporting template (Appendix 2) was somewhat limited in providing the opportunity for teachers to describe their projects. As evaluators we observed that the reports did not seem very extensive; only small boxes were provided to describe projects and answer questions about them, i.e. research methods, impact, sustainability, next steps etc.

4 Results

The table below shows that data was collected and analysed from nearly five thousand people.

Table 2 Respondent numbers per research activity

Point in time	Research Activity	Number of Participants
First CPD session (start of programme for teachers)	Teacher Questionnaire 1	110 (including National SLC)
After first CPD session	Pupil Questionnaire 1	2050
After first CPD session	Pupil Focus Group Meetings Pre-intervention	13 groups (68 pupils)
Spring 2010	'Control' group Pupil Questionnaire (a year above intervention groups)	656
After 1st round of action research	Pupil Questionnaire 2	921
After 2nd round of action research	Pupil Questionnaire 3	958
After 2nd round of action research	Pupil Focus Group Meetings post-intervention	5 groups (33 pupils)
End of final CPD session	Teacher Questionnaire 2	64 (National SLC no longer included)
End of final CPD session	Teacher Focus Group Meetings	9 groups (54 teachers)
At the time of final CPD session	Senior Managers' Questionnaire	38
After final CPD session	Course Tutor Interviews	9 (National SLC no longer included)

4.1 Pupil Questionnaire 1

4.1.1 Statistical Analysis

2050 pupils completed the baseline pupil questionnaires were returned to the researchers in total (by 68 teachers), of which 58.2% were completed by female pupils and 41.8% by males. Most of these pupils were part of mixed gender groups (75.2%), but 21.2% were in all-girls' groups, and a very small percentage (3.6%) were part of all-boys' groups, either in single-sex or mixed-gender schools. More than two-thirds of respondents (70.2%) were from high ability sets; 24.2% were from mixed ability sets and 5.7% from medium ability groups. None of the participating pupils were from low-ability sets.

Just under half of participating pupils (45.3%) were Year 10s – many course participants appeared to have a preference to carry out their intervention with this year group. A much smaller percentage of pupils (13.1%) were in Year 8 and 41.5% in Year 9. 59.5% of respondents were working at KS4 level at the time of pupil questionnaire 1 (academic year 2009-2010 for most of the groups) and 37.5% at KS3 level.

Almost half of the pupil participants (46.5%) were working towards a Triple Science Award and 14.7% of pupils towards an Additional Science Award. 8.6% were in mixed award groups, 4% were doing Core Science and 15.7% had not yet chosen a route. For 9 out of the 68 groups, information about ability level, Key Stage, and the physics qualification the groups were working towards, was not received.

About half of the pupils (52.6%) found physics quite or very difficult; the other half (47.5%) found it quite or very easy (4.6 % of pupils find physics very difficult and 3.4% found it very easy). Looking at differences between boys and girls, 60.2% of girls found physics very or quite difficult while this is 42% for the boys. 57.9% of pupils found the words in physics easy or very easy (this is 47% for the girls and 65% for the boys). 38.5% of pupils found the words quite difficult and 3.6% found them very difficult.

10.3% of pupils claimed to be 'very interested' in physics; significantly, this was 15.6% of the boys and 6.7% of the girls. 50% were quite interested (47.2% of girls and 54.3% of boys) and almost 40% (38.2% of girls and 30.1% of boys) were not very interested or not at all interested in physics. Of the girls, 7.9% said they were not at all interested in physics, while only 4.5% of the boys felt this way.

67% of participating pupils could study physics post-16 at their school but only 14.4% of pupils said they were 'very likely' or 'definitely' going on to study physics after their GCSEs. Significantly, this was 10.8% for the girls and 19.6% for the boys. 46.5% stated that they did not intend to choose physics post-16 (53.2% of the girls and 36.8% of the boys). Furthermore, only 24.9% of pupils claimed to have had talks about careers in physics. Pupils who had had careers talks about physics, most often said they had done so with their science teacher and/or a parent.

39.3% of pupils indicated that in their physics lessons, physics was often linked to their '*everyday life'*; another 40.8% said that this is done sometimes, and according to a fifth (19.9%) of pupils, physics is only rarely linked to their everyday lives. With regards to links with other subjects being made in physics lessons, 12.2% reported that this was done often and 59.1% that it happened sometimes; 28.6 said it never happened. Links to worldwide issues were made often according to 32.3% of pupils; 48.3% said this happened sometimes and 18.9% that this happened rarely.

29.8% of pupils felt that there was not enough time in physics lessons for discussion (33.9% of boys and 28.4% of girls) and 39.1% reported that there wasn't enough time to think things through properly (34.9% of boys and 44.5% of girls. Interestingly, it seems from our data that boys more often than girls felt a need for more discussion time and girls more often than boys needed more thinking time. Between half and two-thirds of participants felt the time available for both of these is about right.
16% of pupils felt that their physics lessons are aimed more at boys; 17.3% of the girls felt this and 14.3% of the boys. 7.8% said that lessons were aimed more at girls; this was stated by 11.6% of the girls and 2.7% of the boys (this result can partly be explained by the large proportion of girls being in all-girls' schools). 75.7% of pupils felt that lessons were aimed both at boys and girls (83.1% of boys and 70.3% of girls). Pupils were significantly more interested in physics when they felt their lessons were aimed at their own gender; this applied to girls and boys.

Girls found physics significantly less interesting and significantly more difficult than boys. Girls also found the words used in physics significantly more difficult than boys. The less difficult pupils in general found physics, the more interested they were in the subject.

There is no statistically significant difference between pupils working at KS3 level and those working at KS4 level in how interested they are in physics, but groups of high and mixed ability are significantly more interested in physics than groups of medium level ability. Also, pupils in groups studying for the triple award and those in groups studying for mixed core, double and triple award were significantly more interested in physics than those in groups studying for additional science or core science (those in mixed qualification groups even more than those in triple qualification groups), or those in groups for which a route hadn't yet been chosen. There was also a significant positive correlation between whether pupils said they had had careers talks and how interested they were in physics.

Pupils were significantly more interested in physics when they indicated that in their physics lessons, physics was 'sometimes' or 'often' linked to their daily life, or to worldwide issues, or to other subjects in their lessons, see table 3.

Table 3. Correlations between physics lessons variables and student interest

(Pearson correlations)	**How interested in physics are you?**
In your physics lessons, how often is physics linked to worldwide issues?	.121 (significant at p<.01)
In your physics lessons, how often is physics linked to other subjects?	.209 (significant at p<.01)
In your physics lessons, how often is physics linked to your everyday life?	.203 (significant at p<.01)

The more interested pupils were in physics, the more likely (significant) they were to indicate that they would choose it after their GCSEs (see table 4). However, of the pupils indicating that they were 'quite interested' or 'very interested', 89.7% were not quite sure whether they would actually choose physics post-16, as they indicated they would 'maybe' choose it (23.4% of the pupils who were very interested in physics said they would definitely choose it post-16).

Table 4. Correlations between student interest and intentions for post-16 take-up of physics

(Spearman's rho correlations)	**How likely are you to study physics after your GCSEs?**
How interested in physics are you?	.606 (significant at p<.01)

Interestingly, the more often pupils indicated that they had had careers talks about physics, the more interested they were in physics (see table 5), but of course the causality of the correlation is unclear here – it may be that the more interested pupils take more initiative to talk with teachers, careers advisers, parents etc about physics careers opportunities.

Table 5. Correlations between physics careers talks reported by students and student interest

(Spearman's rho correlations)	**How interested in physics are you?**
Has anyone ever talked to you about careers in physics?	.156 (significant at p<.01)

Pupils were significantly more inclined to study physics post-16 when they found it less difficult; and boys were significantly more likely to study physics post-16 than girls (p<.001):

Table 6. Likelihood of post-16 physics uptake

		How likely are you to study physics after your GCSEs?					Total
		Definitely not	Not likely	Maybe	Very likely	Definitely	
Gender of Pupil	Female	14.8%	38.4%	35.9%	8.5%	2.4%	100.0%
	Male	7.8%	29.0%	43.6%	14.1%	5.5%	100.0%
Total		11.9%	34.5%	39.1%	10.8%	3.7%	100.0%

Pupils were significantly more interested in physics when the amount of *thinking time* in lessons was 'about right' for them (p<.001). Pupils found physics significantly more difficult when they felt that there was 'not enough' time to think in physics lessons, compared to when they felt the amount of thinking time was either 'about right', or 'too much' (p=.033). However, pupils who said there was 'too much' thinking time were significantly less interested in physics (p<.001). When the amount of *discussion time* in lessons was 'about right' for them, pupils were also significantly more interested in physics (p<.001); when they felt it was 'not enough', they found physics significantly more difficult (p<.001). When the amount of discussion time was 'about right' for pupils they were significantly more interested in physics than when it was either not enough or too much (p<.001).

Girls were most interested in their physics lessons when they felt that the material was aimed more at girls, and least when they felt it was aimed more at boys (the differences were significant). Boys were also most interested in physics when they felt that their lessons were aimed towards boys and least when they felt their lessons were aimed at girls, and again the differences were significant.

There was a significant positive relationship between how easy pupils claimed to find physics and how often they felt it was linked with other subjects (p<.001) and with everyday life (p<.001): the more often they said these links were made in lessons, the easier (less difficult) they found physics; interestingly this relationship was not significant for how often pupils felt physics was linked to worldwide issues.

4.1.2 Summary of responses to open questions in Pupil Questionnaire 1

Below, the most frequent answers to the open questions in the questionnaire are listed. The questions were:

- What things in physics particularly interest you?
- What things in physics don't particularly interest you?
- In what way is physics relevant to your everyday life? List 3 things if you can.
- What kind of career would you eventually like?

Particularly interesting physics topics (n=2050)
Space/solar system/universe 582
Forces 293
Electricity 255
Energy 173
Experiments/practicals 154
Practicals/Experiments 144
Radiation/radioactivity 122

Particularly uninteresting physics topics:
Forces 422
Electricity 258
All of it, most of it 256
Energy 222
Equations, formulas, calculations, maths 143

Gravity 101
Sound 101
None 100
All/everything 95
Magnetism 93
Circuits 67

Magnetism 133
Light 113
Sound 104
Circuits 90
Heat 81
Speed 81
Radiation 79
Gravity 64
space 56

Relevance of physics

- Electricity ("we use it every day")/ electrical appliances mentioned (TV, household appliances, light switches; computers, Xboxes);
- gravity (keeps me on the ground)
- Forces (push/pull)
- Movement (walking/riding)
- Driving a car [speed/distance/time]
- Knowing/understanding how things work
- Don't know/no relevance
- Saving energy (around the house/reduce global warming)
- Cars
- Light
- Sound
- Heat
- Speed
- Cooking - microwave; kettle; toaster; fridge
- Replacing a fuse
- Fixing a plug
- Solar system / star gazing

Careers most mentioned

- Don't know yet/not sure yet (by far the most) 654
- Doctor/medicine 151
- Teacher 132
- Design of some sort (including architecture (45)) 118
- Law (Lawyer/Barrister) 107
- Vet 86
- Sports related: PE teacher, physiotherapist, professional sports(wo)man, fitness instructor 81
- Engineer 68
- Acting 61
- (Performing) arts 57
- Police 48
- Forensic science 47
- Animal related 42
- Army/RAF 39
- Journalism 37
- Game designer 34

- Photographer 33
- Pilot 32
- Fashion 30
- Nurse 29
- Accountant 28
- Biology related 23
- Child related 23
- Media related 22
- Dance 20

4.2 Teacher Questionnaire 1 (baseline)

4.2.1 Statistical analysis

110 teachers completed the baseline teacher questionnaire. Of these, 55.5% were female and 44.5% male. More than half (54.5%) of the course participants had a physics subject background; 12.7% had a background in biology and 9.1% in chemistry. Only very small percentages of teachers had a subject background in environmental science, geology, a (part) science degree or an engineering background. 44.5% had a Bachelors' degree in a physics-related subject; 13.6% had a Masters' degree in a physics-related subject; 5.5% had a PhD; 10.9% had an A level as their highest physics-related qualification; and 9.1% had a GCSE/O-level as the highest physics-related qualification. 1.8% had taught science less than a year; 40% had taught science between 1 and 5 years; 21.8% had 6-10 years experience of teaching science; and 36.4 had taught science for more than 10 years.

58.2% of the teachers had not done any action research before; 36.4% had done some; 68.2% of teachers had used online technology 'a little' before for support; 21.8% said they had used it a lot.

89.1% of teachers said that they often encouraged dialogue between teacher and pupil, and 59.1% often encouraged dialogue between pupil and pupil. Only 24.5% reported to differentiate often for gifted & talented pupils (68.2% did this sometimes). 90% never differentiated for boys and girls.

A little more than a third of teachers often used gender-neutral examples and illustrations; 43.6% did this sometimes. 69.1% reported that they often tried to use non-technical language and analogies; 29.1% did this sometimes. 58.2% of the teachers said that they 'sometimes' linked physics with careers in their physics lessons; 25.5% never did this. 42.7% of teachers reported that they often linked physics topics and 47.3% did this sometimes. 31.7% of teachers said they often made links with other subjects; 49.5% did so sometimes. With regard to making links with everyday life: 44.5% of teachers often did this in their physics lessons and 51.8% sometimes. 28.2% of teachers reported that they often made links with global and social issues in their physics lessons; 56.4% did this sometimes.

Table 7. Use of (physics) teaching strategies as indicated by participating teachers

	Often	Sometimes	Never
In your physics lessons, how often do you link physics with global and social issues?	28.2%	56.4%	15.5%
In your physics lessons, how often do you link physics with everyday life?	44.5%	51.8%	3.6%
In your physics lessons, how often do you link physics with everyday life?	16.4%	58.2%	25.5%
In your physics lessons, how often do you differentiate between boys and girls?	0.9%	9.1%	90.0%

As the teacher sample consisted of only 110 participants, the results below need to be interpreted with care.

There appears to be a significant difference in how much participants in each of the categories of qualification level in physics-related subjects differentiated for boys and girls in their physics lessons: those with a Bachelors' degree in a physics-related subject seemed to differentiate the least and those with a PhD in a physics-related subject the most (only these two qualification categories were significant, so it's not a step-wise correlation).

There is also a significant difference in how often participants in each of the categories of qualification levels in physics linked physics to global and social issues in their classes: those with a GCSE/O level in physics, a Bachelors' or a Masters' degree in physics seemed to do this significantly more often than participants with other physics-related qualifications.

Teachers with a whole degree in science significantly more often differentiated between boys and girls than those in all the other science subject background categories. They also, along with the teachers with a background in physics, significantly more often made links between topics in their physics lessons. Those with a physics background most often linked physics with other subjects in their lessons. Male teachers reported to make links between topics in their physics lessons significantly more often than female teachers.

Teachers with 1-5 and more than 10 years of experience in teaching science linked physics with other subjects significantly more in their physics lessons than teachers with less than 1 and 6-10 years experience.

4.2.2 Summary of responses to open questions in Teacher Questionnaire 1

4.2.3.1 Teachers' concerns about teaching physics

The answers to an open question to teachers about their main concerns with regards to teaching physics can be summarised around the following themes:

- Teacher's own ability to engage and enthuse pupils, making physics relevant (28%)

- Pupils finding physics difficult, both in perception and in reality (21%)
- A lack of engagement of all pupils with the subject, and concerns about progression to post-16 (20%)
- Teacher's lack of confidence in their own teaching of physics, frequently from teachers whose background was not in physics (17%)
- Gender imbalances in girls' enjoyment of and potential progression with physics (15%)
- Keeping their own subject knowledge up to date (6%)
- Concerns about the earlier teaching of their pupils, often by non-specialists (5%)

A wide variety of other concerns were also expressed, including difficulties for pupils with transferability of maths skills, lack of resources (old labs, inoperable equipment, lack of funding, lack of technician time), lack of awareness of career progression, lack of time to complete the curriculum, an uninspiring and 'dumbed down' curriculum, teaching science rather than physics.

4.2.3.2 Teachers' opinions of what needs changing in their own teaching

These are summarised in themes below:

- Increasing the relevance of physics to the pupils: relevance to everyday life (in the subject matter and of careers related to physics), and contexts within the curriculum and of teaching (38%)
- Making lessons more engaging, often in relation to the teacher themselves becoming more informed, or in relation to finding more time to teach (21%)
- Incorporating more information about careers in physics into their teaching (18%)
- Dealing with gender issues, both in relation to the teachers' confidence to deliver, and the girls' confidence in physics (17%)
- Needing opportunities for more/better practical work with working resources (15%)
- Addressing the fact that pupils perceive physics as difficult, and need to have more confidence (13%)

Other commonly reported aspects included: incorporating active learning in lessons, focussing on 'what physics is', and use of role models.

4.3 Links between pupil and teacher variables on the baseline questionnaires

Teachers' indications of their use of various teaching strategies were included in the Pupil Questionnaire 1 data set as pupil variables in order to reveal links between strategies used by teachers and their students' interest in physics, their experienced level of difficulty of physics, their intentions of taking up physics post-16, etc. For example, if teacher X indicated that she often differentiated for boys and girls in her physics lessons, this was indicated as the same value for all of her pupils (i.e. '1' for 'often' on the variable Teacher differentiates for boys and girls); similarly, for the pupils of the teacher who indicated that he 'sometimes' differentiated for boys and girls (this would be a value 2 for all of his pupils on this variable). There were 11 questions in the Teacher questionnaire 1 about teaching strategies, and teachers' ratings to all of these have been added to their pupils' response data sets, thereby effectively becoming pupil 'characteristics'. Correlations were then calculated between student and teacher variables.

From this, it appeared that there is a significant positive relationship between how interested pupils are in physics and how often teachers report that they link physics with everyday life:

Table 8 Significant correlations between teacher's strategies and student interest in physics

	[Pupil] How interested in physics are you?
[Teacher] In your physics lessons, how often do you link physics with everyday life?	.068 (p<0.01)
[Teacher] In your physics lessons, how often do you encourage dialogue between teacher and pupil?	-.044 (p<0.05)

The more often teachers linked physics with everyday life in their lessons, the more interested pupils were in physics. This correlation interestingly does not exist for links made between topics by teachers, for links they made with other subjects, with global and social issues, and with careers in lessons.

There was an interesting significant negative relationship from the data between how interested pupils were in physics and how often teachers indicated that they encouraged dialogue between pupils and themselves.

Table 9 Correlations between teacher's strategies and students' experienced difficulty level of physics

	[Pupil] How difficult do you find physics?
[Teacher] In your physics lessons, how often do you link physics with global and social issues?	.069 (p<0.01)
[Teacher] In your physics lessons, how often do you encourage dialogue between teacher and pupil?	-.044 (p<0.05)

Table 10 Correlations between lesson characteristics as reported by pupils and pupils' experienced difficulty level of physics

	[Pupil] How difficult do you find physics?
[Pupil] How much time is there in physics lessons to think things through properly?	.190 (p<0.01)

Pupils also found physics easier as teachers made more links with global and social issues in their lessons (although we saw before that it didn't make them feel more interested); and when they felt there was enough time in lessons to think things through properly.

There was a very strong positive correlation between how often teachers indicated that they linked physics with everyday life in their lessons, and how often pupils felt that this was happening. This is an important and meaningful result as it seems to show that pupils clearly picked up on what teachers were doing in this area.

Table 11 Correlations between teachers' linking of physics with everyday life and students' reporting of these links being made in lessons

	[Pupil] In your physics lessons, how often is physics linked to your everyday life?
[Teacher] In your physics lessons, how often do you link physics with everyday life?	.070 ($p<0.01$)

For links made with other subjects however, there was no correlation between what teachers said they did and what pupils felt was happening in their lessons. Perhaps this is something that would be less clear to the pupils even if it were happening. For links made with global and social issues, there was no significant correlation either with how often pupils reported that physics was linked to worldwide issues in their lesson.

Encouragingly, there does exist a strong significant correlation between whether pupils said they'd had career talks about physics and whether teachers make links with careers in lessons.

Table 12 Correlations between teachers' linking of physics with careers and students' reporting physics careers talks

	[Pupil] Has anyone ever talked to you about careers in physics?
[Teacher] In your physics lessons, how often do you link physics with careers?	.058 ($p<0.05$)

Significantly, girls found physics less difficult when they had a female teacher than when their teacher was male – but this did not apply to boys. Girls were also considering taking up physics post-16 more when they had a female teacher (the percentage of girls saying 'maybe' here was significantly higher when they had female teachers, and the percentages indicating they were not likely to choose it significantly less). For boys this didn't make a difference. The gender of the teacher did not have an effect on how *interesting* pupils find physics though.

The difficulty levels of physics experienced by pupils varied significantly across their teachers' qualification levels in physics, but there were no obvious patterns. For example, pupils found physics significantly easier when their teachers' highest physics-related qualification was a GSCE/O level, AS level, or Masters degree, but not when this was an A level, degree or PhD.

Interestingly, pupils did not find physics easier or more interesting when their teacher had a physics degree. In fact, pupils found physics significantly easier when their teachers had biology as subject background. Boys found physics significantly more *interesting* when it was taught by teachers with a subject background in engineering (boys only for engineering).

Girls were the least sure about choosing physics post-16 when they had a teacher with a degree in biology (57% saying 'maybe' in this case). Boys were least likely to choose physics post-16 when their teacher had a degree in chemistry or science.

Another statistically significant finding was that when girls had a male physics teacher they felt that their lessons were aimed at girls more than when they had a female physics teacher. During the first student focus group meetings, of which three were carried out in girls' schools, there was one school in which the girls specifically said that they didn't think about whether physics was for girls or for boys, or whether their lessons were aimed at boys or girls. It was a girls' school and all students did physics, so they felt it was a normal thing for girls to study physics at school. These girls had a female physics teacher. Although these views were expressed in one school only, it might provide an insight into this finding: perhaps in girls' schools, either the gender focus is less of an issue because the focus in on girls anyway (teachers' might make the subject relevant for girls in a more implicit way because they don't have to also think about making it relevant for boys). It is also possible that male teachers make more of an effort of making the subject relevant for girls, knowing that the boys are more naturally interested and that they, as a male teacher, can more easily and naturally tap into boys' interests.

4.4 Pupil Questionnaire 2 (Interim Measurement)

37 sets (groups) of interim pupil questionnaires were received in total, with a total of 921 pupils participating, which is 1129 less than in Pupil Questionnaire 1.

4.4.1 Statistical analysis

60.4% of the pupils taking part in the interim measurement were female and 39.6% male. 39.5% were in Year 10 (academic year 2009-10); 42.6% in year 9 and 17.9% in year 8. 66.1% of these pupils were in high ability groups. 31.5% were in mixed ability groups and 2.4 in medium ability groups. 74.7% were in mixed gender groups, 21.7% in all-girls', and 3.6% in all-boys groups.

42% were working at Key Stage 3 and 54.2% at Key Stage 4; 18.1% were studying towards an additional/double science award, 43.1 for the triple award, 14.7% were in a group in which pupils were working towards different qualifications, and 24.0% of pupils were in a group for which no route had yet been decided. In 62.9% of pupil cases, physics could be taken post-16 at their school.

Demographic data were not received for 6 of the 37 classes.

Of the participating pupils in this interim questionnaire 16.9% said they were 'very likely' or 'definitely' going to study physics post-GCSE, and 37.4% said they would 'maybe' do this. 49% confirmed that someone had talked to them about careers in physics, which was 24% more than in the baseline pupil questionnaire.

When asked how interested they were in physics, 9.7% at this measuring point in time were 'very interested'; 47.2% were 'quite interested', 34.9% were 'not very interested', and 8.2% said they were 'not at all' interested in physics. 3.7% found physics very difficult, 42.9% found it quite difficult, 49.5% found it quite easy, and 3.9% found it very easy. The words/terms in physics were found 'very difficult' by 4.1%, 'quite difficult' by 37.5%, 'quite easy' by 53.7% and 'very easy' by 4.6%.

In response to the additional question in this questionnaire, 'Do you find physics more, the same, or less interesting than before?', 28.9% of pupils said they found it 'more' interesting now; 61.0% found it 'equally' interesting, and 10.1% found it 'less' interesting than before. The same additional question was asked about the difficulty level experienced in physics, upon which 28.2% of pupils replied that they found physics 'less' difficult than before, 58.9% found it 'equally' difficult, and

12.9% found it 'more' difficult than before. These generally seem positive results, and will be compared later on.

35.1% felt that physics was 'often' linked to worldwide issues in their lessons; 45.8% thought that happened 'sometimes'. Links to other subjects were 'often' made according to 15.3% of pupils; 'sometimes' according to 55.8% of pupils. 42% felt that links with everyday life were 'often' made in physics classes, and 39.1% said this happened 'sometimes'.

67.3% felt that the amount of discussion time in classes was 'about right'; 26.6% felt that it was 'not enough'. 6.1% feel it was 'too much'. 59.9% felt that there was 'about the right amount' of time to think things through properly; 36.7% felt there wasn't enough time to do this.

4.4.2 Summary of responses to open questions in Pupil Questionnaire 2

The most frequent answers to the open questions in Pupil Questionnaire 2 are listed below. The questions were:

- What things in physics particularly interest you?
- What things in physics don't particularly interest you?
- In what way is physics relevant to your everyday life? List 3 things if you can.
- What kind of career would you eventually like?

Particularly interesting physics topics (n=921)
Space/solar system/universe 563
Electricity/electric circuits 88
Forces 76
Nothing 51
Practicals/Experiments 45
Radiation/radioactivity 35
Electromagnetic waves/spectrum 24
Gravity 20
Magnetism 16

Particularly uninteresting physics topics:
Electricity 166
Forces 158
Equations, formulas, maths 59
All of it, most of it 56
Space, planets, universe, solar system etc 56
Magnetism 39

Compared to the answers to the same open questions in the baseline pupil questionnaire, the same topics are found most and least interesting by the participating pupils as a group; although the topic of energy is no longer in the top 5 of topics found least interesting.

Relevance of physics
Electricity ("we use it every day")/ electrical appliances mentioned (TV, household appliances, light switches; computers, Xboxes; mobile phones);
gravity (keeps me on the ground)
Light
Forces (push/pull)
Movement (walking/driving)
Keeping warm

Driving a car [speed/distance/time]
Knowing how things work/how to fix things
Don't know/no relevance
Saving energy (around the house/reduce global warming)
Cars/driving
Sound
Heat
Speed
Cooking - microwave; kettle; toaster; fridge
Replacing a fuse
Fixing a plug
Solar system / star gazing

No distinct differences can be seen between the responses about the relevance of physics here and those given in Pupil Questionnaire 1.

Careers most frequently mentioned
Don't know yet/not sure yet (by far the most) 248
Doctor/medicine 68
Teacher 58
Design of some sort (including architecture (16)) 52
Law (Lawyer/Barrister) 46
Vet 43
Engineering 35
Acting 27
Animal related 23
Performing arts 22
Police 22
Sports related: PE teacher, physiotherapist, professional sports(wo)man, fitness instructor 22
Biology related 17
Forensic science 16
Business related 15
Photographer 14
Pilot 14
Journalism 14
Psychology 13
Fashion 11

The career interests of the participating pupils don't seem to have shifted very much between pupil questionnaire 1 and 2 – the top 5 of popular careers remains the same, although sports related careers have dropped somewhat in popularity. Of course this may be due to different group compositions between the 2 questionnaires.

4.5 Pupil Questionnaire 3

4.5.1 Statistical analysis

38 groups of pupils took part in the final pupil questionnaire, given to pupils at the end of their teacher's action research interventions. The total number of pupils participating in this final questionnaire was 958 (around the same amount as with Pupil Questionnaire 2, which was 921), of which 57.8% were female and 41.9%

male. This compares to the gender distributions of the earlier questionnaires. Of these pupils, 37.1% were in Year 10 (academic year 2010-11); 19.5% in year 9 and 43.3% in year 11 (of course the pupils have moved up a year, so that none are now in Year 8 anymore and many more than before are in Year 11). 73.2% of these pupils were in high ability groups, a higher percentage than in the dataset of pupils participating in the baseline and interim questionnaires. 20.6% were in mixed ability groups and 6.2% in medium ability groups. 68.6% were in mixed gender groups, 26% in all-girls', and 5.4% in all-boys groups.

Only 13.2% of groups are now working at Key Stage 3 and 80.6% at Key Stage 4; 7.4% of groups were doing Core Science; 12% were studying towards an additional/double science award, 57.6% towards the triple award, 11.4% were in a group in which pupils were working towards different qualifications, and 11.7% of pupils were in a group for which no routes had yet been decided. 51.3% now indicated that they'd had careers talks about physics, and in 36.3% of cases this was with the science teacher, which is by far the highest percentage (parents come second with 14.4%). In 71.6% of pupil cases, physics could be taken post-16 at their school.

Group characteristics were not received for 4 of the 38 classes.

Of the participating pupils in this post-intervention questionnaire 20.9% said they were 'very likely' or 'definitely' going to study physics post-GCSE, and 30.1% said they would 'maybe' do this.

When asked how interested they were in physics, 12.6% at this measuring point in time were 'very interested'; 48.6% were 'quite interested', 31.6% were 'not very interested', and 7.1% said they were 'not at all' interested in physics. 7.2% found physics 'very difficult', 49.1% found it 'quite difficult', 40.8% found it 'quite easy', and 2.9% found it 'very easy'. The words/terms used in physics were found 'difficult' by 42.4%, 'quite easy' by 50.6% and 'very easy' by 6.9%

When pupils were asked to compare their interest in physics, and their experienced level of difficulty of physics to before, 34.6% of pupils said they find it 'more interesting'; 51.8% found it 'equally' interesting, and 13.7% found it 'less' interesting than before.; 25.2% of pupils replied that they found physics 'less' difficult than before, 54.5% found it 'equally' difficult, and 20.3% find it 'more' difficult than before. As with the interim pupil questionnaire, these generally seem positive results. A statistical comparison (t-tests) will also be made to compare pupils' answers about the level of difficulty and interest experienced between Questionnaire 1 and 3, and 2 and 3, later on in the report.

36% felt that physics was 'often' linked to worldwide issues in their lessons; 46.6% thought this happened 'sometimes'. Links to other subjects were 'often' made according to 21.7% of pupils; 'sometimes' according to 58.4% of pupils. 40.9% felt that links with everyday life were 'often' made in physics classes, and 41% said this happened 'sometimes'.

66.6% felt that the amount of discussion time in classes was 'about right'; 28.6% felt that it was 'not enough'. 4.81% felt it was 'too much'. 62.1% felt that there was about the 'right amount' of time to think things through properly; 35.5% felt there wasn't enough time to do this.

The differences between girls and boys with regard to how interested they are and how difficult they find physics remain the same: girls keep finding physics significantly less interesting and significantly more difficult than boys. Girls also find the words used in physics significantly more difficult than boys. As pupils find physics easier, they are much (and significantly) more interested in physics.

There is again no statistically significant difference between pupils working at KS3 and those working at KS4 in how interested they are in physics, but groups of mixed ability are significantly more interested in physics than groups of medium level ability.

Pupils remain significantly more interested in physics when they indicate that their physics lessons are 'sometimes' or 'often' linked to their daily life, or to worldwide issues, or to other subject lessons, see table 12:

Table 13. Correlations between physics lessons variables and student interest

Pearson correlations	How interested in physics are you?
In your physics lessons, how often is physics linked to worldwide issues?	.192 (significant at p<.01)
In your physics lessons, how often is physics linked to other subjects?	.298 (significant at p<.01)
In your physics lessons, how often is physics linked to your everyday life?	.271 (significant at p<.01)

The more interested pupils are in physics, the more likely (significant) they are to indicate that they will choose it after their GCSEs (see table 13), however, as before, a large percentage (83.8%) within the group of pupils indicating that they will 'maybe' choose physics post-16, are 'quite interested' or 'very interested' in the subject.

Table 14. Correlations between student interest and intentions for post-16 take-up of physics

Spearman's rho correlations	How likely are you to study physics after your GCSEs?
How interested in physics are you?	.606 (significant at p<.01)

As with the first and second pupil questionnaire, the more often pupils indicate that they have had careers talks about physics, the more interested they are in physics, but of course the causality of the correlation is unclear here – it may be that the more interested pupils take more initiative to talk with teachers, careers advisers, parents etc about physics careers opportunities. See table 14.

Table 15. Correlations between physics careers talks reported by students and student interest

Pearson correlations	How interested in physics are you?
Has anyone ever talked to you about careers in physics?	.132 (significant at p<.01)

Looking at gender differences in the intentions to study physics post-16 (see table 15), there is a clear difference with the answers in pupil questionnaire 1: both boys and girls seem clearer about their intentions, which means higher percentages of pupils that they will definitely not take it but also for higher percentages of pupils that they will take the subject post-16. (The percentages of the first pupil questionnaire are indicated in brackets in table 15).

Table 16. Gender*Likelihood of post-16 physics uptake Cross tabulations

		How likely are you to study physics after your GCSEs?					
		Definitely not	Not likely	Maybe	Very likely	Definitely	Total
Gender of Pupil	Female	25.6% (14.8%)	33.1% (38.4%)	26.7% (35.9%)	9.2% (8.5%)	5.5% (2.4%)	100.0%
	Male	11.6% (7.8%)	24.2% (29.0%)	35% (43.6%)	19.6% (14.1%)	9.6% (5.5%)	100.0%
Total		19.7% (11.9%)	29.3% (34.5%)	30.2% (39.1%)	13.6% (10.8%)	7.2% (3.7%)	100.0%

Pupils are still significantly more inclined to study physics post-16 when they find it less difficult; and boys are again significantly more likely to study physics post-16 than girls.

Pupils are significantly more interested in physics when the amount of *thinking time* in lessons is 'about right' for them. Pupils find physics significantly more difficult when they feel that there is not enough time to think in physics lessons, compared to when they feel the amount of thinking time is either about right, or too much. When the amount of *discussion time* in lessons is 'about right' for them, pupils are also significantly more interested in physics; when they feel it is 'not enough', they find physics significantly more difficult.

Girls and boys are both most interested in their physics lessons when they feel that lessons are aimed equally at boys and girls, and least interested when they feel it is aimed more at the opposite sex (the differences are significant).

Pupils find physics significantly easier when physics is linked to other subjects, everyday life and worldwide issues in their lessons, see table 16:

Table 17. Pearson correlations between physics lessons variables and difficulty level of physics as reported by pupils

Pearson correlations	How difficult do you find physics?
In your physics lessons, how often is physics linked to worldwide issues?	.084 (significant at p<.05)
In your physics lessons, how often is physics linked to other subjects?	.179 (significant at p<.01)
In your physics lessons, how often is physics linked to your everyday life?	.227 (significant at p<.01)

The easier they find physics, the more likely pupils are to choose physics post-16 (table 17). This corresponds with comments in pupil focus group meetings, where often pupils related their post-GCSE choice of physics to whether they thought they could cope, as they thought/had heard that the subject would get hard at AS/A level.

Table 18. Pearson correlation between student experienced level of difficulty of physics and intentions for post-16 take-up of physics

Pearson correlations	**How likely are you to study physics after your GCSEs?**
How difficult do you find physics?	.434 (significant at $p<.01$)

Looking at what the teachers have indicated in their final questionnaires with regard to how often they:

- make links everyday life, worldwide issues, and other subjects in physics lessons
- differentiate for boys and girls or for able pupils
- use non-technical language
- encourage pupil-pupil dialogue
- encourage teacher-pupil dialogue

It appears that pupils are significantly more interested, and find the subject significantly easier, when teachers indicate more that they link physics with global and social issues:

Table 19. Significant correlations between teacher's strategies and student interest in physics

	[Pupil] How interested in physics are you?
[Teacher] In your physics lessons, how often do you link physics with global and social issues?	.125 ($p<.001$)

Table 20. Correlations between teacher's strategies and students' experienced difficulty level of physics

	[Pupil] How difficult do you find physics?
[Teacher] In your physics lessons, how often do you link physics with global and social issues?	.145 ($p<0.01$)
[Teacher] In your physics lessons, how often do you link physics with other subjects?	-.141 ($p<0.01$)
[Teacher] In your physics lessons, how often do you use non-technical language?	-0.077($p<0.05$)

Pupils however find physics significantly more difficult when teachers say they make more links with other subjects, and when they use non-technical language more often in physics lessons as can be seen from the same table.

4.5.2 Summary of responses to open questions in Pupil Questionnaire 3

Below, the most frequent answers to the open questions in this final questionnaire are listed, as before with the first and interim pupil questionnaire. The questions were identical to those previous questionnaires, with a few additional questions:

- What things in physics particularly interest you?
- Is there anything you have found particularly interesting in physics over the last couple of months?
- What things in physics don't particularly interest you?

- In what way is physics relevant to your everyday life? List 3 things if you can.
- What kind of career would you eventually like?

Particularly interesting physics topics (n=958)
Space/solar system/universe/stars/earth and beyond (581 pupils)
Electricity / Circuits (83)
Radiation/radioactivity (63)
Forces (60)
None/ not much/ nothing (59)
Practicals/Experiments (57)
Nuclear physics (47)
How things work/were formed (40)
Energy (32)
Light (29)
Electromagnetic spectrum/waves (23)
Energy (21)
Magnetism (17)
Gravity (15)
Waves (9)

Particularly uninteresting physics topics:
Electricity/circuits (190)
Forces (170)
All of it, most of it, everything (68)
Equations, formulas (46)
Energy (34)
Magnets (20)
Convection (20)
Gravity (19)
Conduction (17)

Particularly interesting topics recently 575 pupils answered this question; most mentioned:
Space/solar system/universe etc. (297 pupils)
Electricity / Circuits (61)
Nuclear physics / fission/fusion (58)
Radiation/radioactivity (41)
Electromagnetic spectrum/waves (31)
How things work/were formed (26)
Forces (24)
Light (24)
Waves (23)
Energy (21)
Practicals/Experiments (16)
Environment/global warming (14)
Gravity (12)
Magnetism (9)
Theory (9)

The clearest difference between the answers here and to the previous pupil questionnaires about physics topics students are particularly interested and unintersted in in physics are that radiation/radioactivity are now included high up in the topics they find most interesting. In physics topics they have found most interesting *recently*, nuclear physics is also in the top 4 of topics.

Relevance of physics

Electricity ("we use it every day")/ electrical appliances mentioned (TV, household appliances, light switches; computers, X-boxes);
Gravity
Forces (push/pull)
Movement (walking etc)
Travelling [speed/distance/time]
Technology
Energy / Saving energy (around the house/reduce global warming)
To keep warm
Knowing how things work
Not sure
Cars
Light
Sound
Heat
Speed
Cooking - microwave; kettle; toaster; fridge
Replacing a fuse
Fixing a plug
Solar system / star gazing
Safety
Radiation / mobile phones / microwaves
Everything

Careers most frequently mentioned

Don't know yet/not sure yet (by far the most) 272
Doctor/medicine/surgeon 121
Engineering 51
Teacher 51
Law (Lawyer/Barrister) 44
Veterinary/animal related 40
(Performing) arts 38
Design 28
Physiotherapy 28
Science-related 25
Biology related 20
Forensic science 20
Psychologist 19
Business 18
Music 17
Journalism 17
Accountancy 16
Animal related 15
Pilot 14
Architecture 13
Army/RAF 13
Fashion 13
Sports related 13
Police 12

Police 12
Chemistry related 11
Dance 10

In the most popular careers amongst students, engineering has climbed up somewhat, to the (shared) second most popular career. Even though it is possible that teachers' interventions are the cause of this, it could also have to do with chance factors.

At the end of the questionnaire there was an open question about whether pupils had any other comments about their physics lessons, particularly over the last couple of months. The answers given to these questions were often quite positive and indicated an improvement. Sometimes pupils used the space to indicate what they enjoyed or what they would like to see more of. Some gave negative comments as well. The complete range of answers can be found in **Appendix 1.**

4.6 Statistical comparisons between Pupil baseline, interim and final questionnaires

4.6.1 Statistical comparisons between Pupil Questionnaire 1 and 2

A data set was compiled which only included the schools returning pupil questionnaires 1 and 2. This would allow for a straight comparison between the same pupils.
Cross-tabulations with Chi-square and t-test calculations were then carried out to compare the two data sets according to all the variables that are of interest. There are some striking results.

Pupils found physics significantly less difficult in the second measurement (the percentage finding physics 'quite difficult' or 'very difficult' dropped from 52.6% to 46.6% between the two measurement points). However, the percentage of pupils finding physics 'quite interesting' or 'very interesting' fell from 60.3% to 56.9%, and this is a significant change as well. Looking at the statistical analyses, there seems to be a much wider spread in answers to this question at the time of the 2nd pupil questionnaire, which may partly account for the significant difference.

This significant drop in interest in physics seems contradictory to the 28% of pupils saying that they now found physics more interesting and it raises the question whether pupils felt they had to answer this question positively as many of them may have been aware that the teacher was making changes to their classes.

Table 21. Comparisons between answers to Pupil Questionnaire 1 and 2

	Pupil Questionnaire 1	Pupil Questionnaire 2	Significance level of difference in answers to question
Finding physics very or quite interesting	60.3%	56.9%	.000*
Finding physics very or quite difficult	52.6%	46.6%	.391
Finding words/terms used in physics very or quite difficult	42.1%	41.6%	.245
Definitely or very likely choosing physics post-16	14.4%	16.9%	.000*
Reporting careers talks	24.9%	49%	.000*
Physics often linked to other subjects in classes	12.2%	15.3%	.339
Physics often linked to everyday life in classes	39.3%	42%	.636
Physics often linked to worldwide issues in classes	32.3%	35.1%	.004*
Reporting 'not enough' time for discussion	29.8%	26.6%	.044*
Reporting 'not enough' time for reflection	39.1%	36.7%	.024*

*Significant at t<0.05)

Pupils in the interim measurement reported to have had far more careers talks, with 49.0% now saying 'yes' to the question 'Has anyone ever talked to you about careers in physics?', whereas before this was only 24.9% in this particular group of pupils. This difference is significant. Pupils were asked to indicate which people they had had careers talks with about physics (parents/science teacher/form tutor/careers adviser/other), and when we look at where the changes in reported careers talks are with regard to these people, there is a significant change (increase) for the science teacher. This confirms that changes have taken place in lessons.

There is also a significant positive change in how often pupils report that physics is linked to worldwide issues in classes. Significantly more pupils are now saying that this happens 'often'.

There are significant changes for the reported discussion time in classes, and the amount of thinking time has also changed significantly, with fewer pupils saying there is 'not enough' and more saying that it is 'about the right amount'.

With regard to the Research Strand areas of their teachers' projects (See Section 3), the percentage of pupils reporting to have had careers talks about physics at the interim measuring point was significantly more when their teacher were doing a project in the area of *Careers & Guidance*. 67% of pupils of these teachers said that they'd had careers talks in physics, whereas in the other research areas this is around 30-53% of pupils (the 53% is within the action research area of *Progression*, but only a few teachers carried out an action research intervention in this area). It is clear that teachers' efforts to include career options in their physics lessons had been noticed by their pupils.

There are no significant differences to changes in difficulty levels experienced by pupils in the different strands of interventions, but in the *Learning & Teaching* and the *Careers & Guidance* interventions, pupils found physics more difficult in this second measurement than the pupils who had undergone interventions in the other strands. Of course it is not clear which factors exactly may be responsible for these differences.

4.6.2 Statistical comparisons between Pupil Questionnaire 1 and 3

A dataset was compiled of the schools which returned both Pupil Questionnaires 1 and 3, to allow for a straight comparison between the same pupils.

Independent samples t-tests were then carried out to compare the two data sets according to all the variables that are of interest. There are only a few significant differences though, and these are that pupils report a significantly higher level of time for reflection in classes, and that pupils report to be significantly less likely to choose physics post-16. Pupils also report significantly more careers talks about physics than before the teachers' interventions, and these are significantly more often by science teachers (largest difference), parents, careers advisers, and form tutors.

Looking at the Research Cluster areas of their teachers' projects, the percentage of pupils reporting to have had careers talks about physics at the final measuring point are highest when their teacher is doing a project in the area of Careers & Guidance: 74% of pupils of these teachers say that they have had careers talks in physics, whereas in the other research areas this is between 40-50% of pupils. These differences are significant.

The reflection time reported by pupils is not significantly different in the research strands.

4.6.3 Statistical comparisons between Pupil Questionnaire 2 and 3

The same method of analysis was performed for Pupil Questionnaires 2 and 3 to search for differences in pupil views and attitudes. Again there are only a few significant differences, this time pupils again indicate that they are significantly less likely to choose physics post-16, but they are on the other hand significantly more interested in physics. It is difficult to explain these results, which may be seen as somewhat contradictory.

Between the interim and final measurement there is no longer a significant increase in reported careers talks about physics, which makes sense as this already happened between the baseline and interim questionnaires. However, a significant increase in careers talks with parents and careers advisers is again reported.

The following table summarises the comparisons of pupils' responses to the above questions between the baseline, interim and final pupil questionnaires:

Table 22.

	Pupil Questionnaire 1	Pupil Questionnaire 2	Pupil Questionnaire 3
Finding physics very or quite interesting	60.3%	56.9%[^]	61.2%[**]
Finding physics very or quite difficult	52.6%	46.6%	56.3%
Finding words/terms used in physics very or quite difficult	42.1%	41.6%	42.4%
Finding physics more interesting than before	n/a	28.9%	34.6%
Finding physics less difficult than before	n/a	28.2%	25.2%
Definitely or very likely choosing physics post-16	14.4%	16.9%[^]	20.9%[*/**]
Reporting careers talks	24.9%	49%[^]	51.3
Physics often linked to other subjects in classes	12.2%	15.3%	21.7%
Physics often linked to everyday life in classes	39.3%	42%	40.9%
Physics often linked to worldwide issues in classes	32.3%	35.1%[^]	36%
Reporting 'not enough' time for discussion	29.8%	26.6%[^]	28.6%
Reporting 'not enough' time for reflection	39.1%	36.7%[^]	35.5%[*]

[^] Significant difference in answers to question between baseline and interim measurement

[*] Significant difference in answers to question between baseline and final measurement

[**] Significant difference in answers to question between interim and final measurement

We can clearly see now in which areas there has been most change between the beginning, the middle and the end of the Action Research for Physics programme:

- Student interest in physics has fluctuated
- Student intentions to study physics post-16 have significantly increased at both measurement points 2 and 3
- Students reported significantly more careers talks in the middle of the project and this increase has been sustained till the end of the project
- After teachers' first rounds of action research, a significant increase in links made to worldwide issues in lessons has been reported and this has been sustained till the end of the project
- Pupils report more time for discussion between measurement points 1 and 2, and more time for discussion between measurement point 1 and 2, and 1 and 3

4.7 Teacher Questionnaire 2

4.7.1. Statistical analysis

A total of 64 teachers took part in the final teacher questionnaire. This is more than a third less than the first teacher questionnaire.

Generally, the teachers felt positive about taking part in the ARP programme: 56.3% were very positive and 42.2% positive about this.

25% felt that their participation in the programme had been very effective in increasing their pupils' engagement with physics. 70% felt it had been quite effective in doing so.

64% of teachers indicated that they felt an increased motivation/enthusiasm to teach physics since they started the programme. 50% of the teachers said that their own interest in teaching physics had increased since they started the programme. For the remaining 50% it had stayed the same.

With regard to learning about action research, 23.4% of teachers felt that they had learnt 'a lot' about this during the programme. Another 67.2% said they had learnt 'quite a lot' about action research. 45.3% found action research 'very useful' in terms of improving classroom practice, and 54.7% found it 'quite useful'.

4.7.2 Summary of responses to open questions in Teacher Questionnaire 2

The final teacher questionnaire contained 5 open questions:

- Please explain how you feel about the usefulness of Action Research
- Please outline any changes you have made to your practice as a result of the Action Research for Physics Programme
- Please briefly outline any changes you have made to your classes as a result of the programme
- Please specify any changes you have made to your schemes of work
- Any other comments

Some striking answers to these questions are shown below. For the complete overview of answers, please refer to appendix 1.

Please explain how you feel about the usefulness of Action Research:

> *It allows you luxury of being able to trial new interventions, reflect on their effect and modify this intervention.*
>
> *It has made me engage in the subject as I have had to think of different ways of making it relevant.*
>
> *It has been useful finding out the difference between my delivery and what the pupils have understood. Less useful though has been the knowledge that I may have increased the uptake of Physics at KS4 but made a rod for my own back because pupils who would otherwise not take Physics believe that it is do-able and easy. I now worry about my KS4 results.*
>
> *My view of the action research methodology is that it is a formalised version of common teaching practice; all teachers plan, implement and reflect and evaluate learning activities - this is simply good practice. The AR methodology is good for making tacit assumptions more explicit and connecting them to a theoretical knowledge base.*
>
> *The Action Research is a catalyst to question current practice and is a stimulant to innovate in the classroom. Such things would be possible without the structure of an Action Research project but would not necessarily happen without the motivation conferred by a structured programme.*
> *I feel I have learnt quite a lot of the past 18 months. The project has helped me understand the pupil better and what they want out of lessons. I have been able to improve my own practice as well especially with regards to behaviour management.*
>
> *The discussions with other colleagues provide an opportunity to learn about new good practices which I then went away and tried. Feedback from pupils helped me plan for future lessons.*

86% of the teachers said that they have made changes to their classes as a result of the programme as a whole. Discussion time in classes was increased by 72% of teachers over the course of the programme and reflection time by 57.8%, a distinct difference. 50% have changed their Schemes of Work.

Please outline any changes you have made to your practice as a result of the Action Research for Physics Programme:

> *I have planned and used some small group discussion activities. Some of these worked well and some did not. Some of the tasks were too challenging but some were pitched just right. The pupils enjoyed having the opportunity to discuss physics problems together. I will certainly use more small group discussions in my physics lessons in future.*
>
> *I am going to develop ways of teaching the Maths of Physics in specific ways that encourage pupils' confidence rather than relying on the Maths department to cover these topics.*
>
> *My questioning has changed. I am now giving pupils thinking time which helps them to think through the questions and as a result phrase their answers better. My language has also improved as I am using every day terms before introducing technical terms.*
>
> *My triple science pupils are more confident about the subject. My questioning techniques and language use throughout my lessons are more differentiated to meet the ability and learning style of my pupil. Most of my pupils, especially the girls are opting to study physics for A-levels*

I found the process of holding the conversations with pupils was very useful however it highlighted that I need to develop more opportunities for the class to develop independent learning skills

Using concept maps to consider the best order to teach lessons in so that they flow well and key concepts are taught and understood before progressing to the next set of concepts. Giving concept maps worked fairly well in giving an overview of the topic - it was even better for pupil revision. Teachers have also found the maps helpful in their planning.

Tend to set up practical work at beginning of lesson and let pupils consider implications. Incorporate short practical hands on activities wherever possible (or Hollywood style film clips then discuss physics of them)

I began to tackle to conceptual "Big Question and Bigger Question" topic descriptors at the beginning of a new topic. I have begun to think of new ways to engage pupils by using their own understanding and perception of the world as a starting point.

I have learned that able pupils are sometimes/usually able to look and take an interest in things which I thought they would not understand. I would definitely continue this practice.

Cooperative learning strategies embedded in everyday practice - becoming the normal part of my lesson planning and learning activities for pupils.

Please briefly outline any changes you have made to your classes as a result of the programme:

Now include information on careers on a more regular basis with better use of specific case studies

When the lesson requires calculations I have tried to simplify with words and demos before introducing the calculation/formula

I now use examples that are not so male-oriented, e.g. when discussing forces and acceleration I now refer to animals instead of cars. I try to make more explicit links to applications of physics at the start of learning activities instead of as an add-on at the end of a lesson. I avoid teaching the equation first and then the physical meaning of it. Now I teach the physical meaning of a concept and define it only after I have done this. I have gained some ideas about physics careers that I will include in my lessons in the future.

Ideas shared by other delegates have been applicable to my school and elements of their practice have been integrated into lessons at my school

Fewer questions to the whole class. More independent finding out from the pupils.

I try to increase engagement in lesson to the class as a whole and sometimes target individual pupils or pupil groups. I have increased the number of different activities I do especially with regards to starters and plenaries.

I am now taking into account observations from my project to adjust or plan my lessons so they are pupil centred to ensure learning occurs.

I use mini white boards in a different way - results of research findings from my pupil researchers. I use pupil voice more. I really avoid using a hand-up approach.

I am constant looking at ways to get pupils interested in physics and science. I have thought about things that I can do in the classroom that will explain things to the children in a way that they understand. I have thought about ways that I can engage the pupils that I teach

More awareness of other factors that influence girls' understanding of physics - allow girls to see the bigger picture by reinforcing links between topics ensure Physics is introduced in a context relevant to girls use of relevant analogies in teaching.

-Changes to SOW/discussions with colleagues; -regular questionnaires to check confidence.
Lessons are more about why they are taught as opposed to what is taught; Pupils are seeing physics as something different, not just good or bad.

More sympathetic to (perceived) problems in understanding - more aware of pupils' lack of MATHS skills holding them back. More aware of me pushing the relevance to life/careers etc.

Careers incorporated more firmly. I teach the maths before the science to remove that barrier.

Please specify any changes you have made to your schemes of work:

Electricity GCSE scheme of work was modified and adapted as a result of pupils comments regarding repetition of topics/practicals/over use of equipment

The year 10 and 11 SoW is under review for the new GCSEs and will incorporate many new ideas of mine and other participants

I have embedded a discussion activity about different energy resources in the SoW.

I wrote a new year 9 scheme of work for electricity which aimed to increase relevance to pupils.

8J moving on (exploring science) is now based around formula one and how speed drag friction and magnets can be shown in this example.

I re-wrote my scheme of work for P6 Waves and Radiation in 21st C Physics to incorporate objectives and plenary questions for each lesson.

Updated the KS4 schemes of work to include careers and context led lessons. There are also links to e-resources. The schemes of work are a day to day document

All teachers will be asked to use the introductory applications lessons

Big + Bigger Questions at start of topic.; Trying to cut down SOW to remove unnecessary lessons ore condense lessons; Including more real-life science and discussion than SOW currently permits

I have written a brand new SOW for core science physics
MORE AND more questions and simple and easy to understand experiments

4.7.2.1 Perceived changes in teacher confidence

With regard to changes in teacher confidence, the most affected are:

- Teachers' ability to make physics relevant (78.1% felt their confidence in this area has increased)
- Teachers' ability to get pupils engaged in physics (78.1% felt their confidence in this area has increased)
- Teachers' ability to increase pupils' awareness of careers/futures in physics (70.3% felt their confidence in this area has increased)
- Teachers' ability to make abstract physics more 'visible' for pupils (70.3% felt their confidence in this area has increased)
- Teachers' ability to make the most of resources (62.5% felt their confidence in this area has increased)
- Teachers' ability to boost pupils' confidence in physics teachers' ability to get pupils engaged in physics (62.5% felt their confidence in this area has increased)

- Teachers’ ability to get girls engaged in physics (59.4% felt their confidence in this area has increased)
- Teachers’ ability to boost girls’ confidence in physics teachers’ ability to get pupils engaged in physics (56.3% felt their confidence in this area has increased)
- Teachers’ confidence in their subject knowledge has increased the least (28.1% felt their confidence in this area has increased)

4.7.2.2 Changes in teaching strategies

Teachers were asked about a number of teaching strategies, and how often they made use of these in their physics lessons. Below is an overview of these and how often teachers indicated they used them:

- Encouraging dialogue between teacher and pupil (96.9 % often, 3.1% sometimes)
- Encouraging dialogue between pupil and pupil (75% often, 23.4% sometimes)
- Linking physics with careers (34.4% often, 57.8% sometimes, 7,8% never)
- Linking physics with everyday life 79.7% often, 18,8% sometimes)
- Linking physics with global and social issues (43.8% often, 53.1% sometimes)
- Linking physics with other subjects (40.6% often, 53.1% sometimes)
- Making links between topics (70.3% often; 26.6% sometimes)
- Using non-technical language (78.1% often; 20.3% sometimes)
- Using gender-neutral examples and illustrations (57.8 often, 34.4% sometimes)
- Differentiating for gifted and talented pupils (32.8% often, 57.8% sometimes)
- Differentiating between boys and girls (4.7% often; 26.6% sometimes, 60.9% never)

These answers can be statistically compared with the answers to the same questions in the baseline teacher questionnaire, as the questions were deliberately kept exactly the same. From Paired T-test analysis, it was found that the participating teachers significantly more often used gender-neutral examples in their physics lessons at the end of the programme (t=.014), and they also linked physics with other subjects significantly more often (t=0.003). In the other variables within this question, no significant differences can be seen.

4.7.2.3 Teachers’ views on impact of their interventions on their colleagues, department, and the wider school

As for the impact of their interventions on their colleagues, department, and the wider school, the findings indicate the following:

- 11% said their colleagues were not very interested in their new approach to teaching physics
- 31% said their colleagues were interested in their new approach to teaching physics but were not adopting these in their own lessons
- 39% said their colleagues were interested in their new approach to teaching physics and were adopting these in their own lessons
- In 22% of cases, the Head of Department was using changes in the way participating teachers teach physics to help improve the teaching of physics throughout the department
- 31% reported that changes in the way they teach physics are/will be discussed or implemented on a wider school level

- 11% indicate that changes in the way they teach physics are/will be discussed with or implemented in other schools they work with

4.7.2.4 Other important findings reported by teachers

Listed below are examples of teachers' responses to the question: Are there any other important findings from your action research intervention that you would like to mention?

> *Careers information needs to be drip-fed to pupils on a frequent basis in order to have a better impact. Focus careers information on the lesson topic. Try to get pupils to provide their own understanding of how a specific career is relevant to a lesson topic.*
>
> *I feel that other research into when children make decisions on career options/subject likes and dislikes may show that these are formed much earlier in a child's life and that all we can do as secondary science teachers is encourage the uptake into further education to those who are already favourable towards science learning.*
>
> *The realisation that one type of intervention will make a little difference and that a combination of intervention actions will deliver maximum results towards the uptake of Physics.*
>
> *Despite increases in perception of ability and interest in Physics intentions of girls to take Physics at A level seem unchanged. A vicious circle needs to be broken*
>
> *The pupils appreciate having their opinions listened to as to how a class is taught and rarely notice if their thoughts are acted upon or not!*
>
> *Practices recommended in the Girls in Physics project also apply to boys.*
>
> *It might be useful to raise the profile of action research generally in some way with Heads of Department perhaps with some guidelines as to how it might be used if it is occurring in a department.*
>
> *Unexpected outcome was that Year 10 pupils who received the intervention have now set up their own lunchtime club passing on the practical and explanation to Year 8 pupils.*
>
> *Poor prior experience of Physics that it is boring or hard was very difficult to shift .When doing the questionnaire pupils said things like 'The P7 unit was good but I still hate Physics'. They didn't equate the two as they had had different teachers for the other units.*
>
> *The project helped to develop pupils' written communication skills but encouraging them to write with the purpose of other pupils reading their work. The project was particularly successful for one of my pupils who suffers from Asperger's Syndrome who was unable to speak to other pupils yet could write to them very fluently. Over the past year this pupil now has the confidence to hold conversations with other pupils. Being able to help someone with their personal as well as academic*
>
> *I think the intervention has made the relevance of physics more explicit. It seems to have made the pupils more certain about whether they are interested in taking physics post 16. The actual level of uptake of physics from the intervention group will become clear in September when they return to sixth form.*

4.7.2.5 Teachers' remaining concerns

Listed below are examples of teachers' responses to the question:
Do you have any remaining concerns about teaching physics?

I believe we need a deputation to institutions for higher education to impress on applicants that Physics although not strictly needed is desirable especially in these days of competition.

How to incorporate all of the ideas within the constraints of syllabus delivery and exam and coursework deadlines.

Traditional methodology used in GCSE Physics course. Relevance of material to pupils and future careers

The more I improve my subject knowledge the more I realise I need to learn.

Main concern is making all of the physics content in 21st century science relevant to everyday life

I feel that the battle can often be from external stimulus such as people thinking science and scientists are geeks.

Still looking at strategies for pupils who struggle with mathematics and concepts to allow differentiation from A to E grade in the same lesson.*

I think my next step would be to find more examples of where physics works in the pupils' environment. Some pupils do still comment that physics lacks relevance to them.

I still feel that KS4 physics is very dry and I hope that the Y8 pupils I have worked with won't get put off physics at KS4.

I don't, but I do have concerns that when taught by people out of specialism there is a tendency to teach it badly.

I still feel physics is very engaging and interesting at KS 3 but when we get to KS4 its curriculum lacks sufficient contemporary subject matter and drifts too much into areas that would easily (and sometimes are) taught elsewhere.

Pupil perception that it's hard and there are softer options that will get them guaranteed A grades - difficulty getting them to believe that a B in Physics could be worth more than an A in Psychology

4.8 Impact of teachers' action research interventions

In their final action research reports, teachers were asked to indicate the impact they felt their intervention was having or would be having (the tick boxes: No change / A little change / Some change / Major change were given). When comparing these impact indications of teachers across the research strands, there appeared to be significant differences. We can see in the table below that this was expected to be the highest when the intervention was in the area of Learning & Teaching, perhaps not surprising.

Table 23. Impact of their interventions as estimated by teachers across the research strands

	Action Research Strands					
	Learning & Teaching	**Classroom Management**	**Careers and Guidance**	**Progression**	**Other / Combination**	**Total**
A little change	8.4%	51.1%	.0%	.0%	24.6%	16.2%
Some change	18.0%	33.7%	73.7%	100.0%	35.1%	38.4%
Major change	73.6%	15.2%	26.3%	.0%	40.4%	45.5%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

When using the senior managers' views of impact levels on a variety of factors, it also appears that this impact is deemed the strongest for action research interventions in the area of Learning & Teaching. We need to keep in mind here that senior managers may have consulted the teachers about the impact and therefore these findings correspond.

The Learning and Teaching interventions had a significantly higher impact on pupil attitudes to physics, pupil learning, and post-16 uptake of physics, according to the senior managers. However, the interventions in the areas of Careers and Guidance and in the combined strands had significantly more impact on pupil performance than those in the other strands, as indicated by the senior managers' answers in their questionnaire.

4.9 The Senior Managers' Questionnaire

This questionnaire was sent to the senior managers of the participating teachers when the course was about to finish. It was completed and returned by 38 managers.

34% of the senior CPD managers (12 people) are Assistant Headteachers or Assistant Principals. 23% (8 people) are Deputy Headteachers or Associate Principal. 11.4% (4) are Heads of Science and 8.6% (3) are Heads of Physics, and another 8.6% (3) carry the role title of CPD Manager or CPD Coordinator. 5.7% or 2 people are Curriculum Leaders (for Science or general). 3 people have other roles, such as Director of Specialism, Professional Mentor, and Head of Faculty. 3 people did not indicate their roles within the school.

19.4% said they were 'very aware' of the ARP course content before the course started. Another 19.4% felt 'quite aware' of this. 47.2% did not feel they were very aware and 14% said they were 'not at all aware'.

Questions were asked in this survey about how aware CPD managers felt they were about the course content before the course started; and how aware they felt they were about it at the time of filling in the questionnaire. Compared to before the course started, the awareness has much increased, as 69.4% now feel quite aware about the course content (16.7% think they are now very aware). 14% do not feel very aware, or at all aware about the course content at present.

52.6% of the managers indicated that they thought the teachers' participation in the course had been 'very useful'; 39.5% found it 'quite useful'.

Factors that played the strongest roles in letting the teachers participate in the ARP programme, according to the managers, were:

- Teacher development (47% indicated this as a 'very strong factor', 48% as 'quite a strong factor')
- Pupil needs (44% indicated this as a 'very strong factor', 47% as 'quite a strong factor')
- Estimated impact on a wider school level (33% indicated this as a 'very strong factor', 58% as 'quite a strong factor')

Other contributing factors according to the respondents were:

- The IMPACT award attached to the course (31.4% indicated this as a 'very strong factor', 42.9% as 'quite a strong factor')
- Estimated impact on the teacher's department (22% indicated this as a 'very strong factor', 58% as 'quite a strong factor')
- High regard of the course (22% indicated this as a 'very strong factor', 50% as 'quite a strong factor')
- High regard of the provider (22% indicated this as a 'very strong factor', 50% as 'quite a strong factor')

The managers' views on the impact of the teachers' participation in the course was strongest in the areas of:

- Other teachers in the department (31.6% says 'Quite a lot'; 28.9% 'A reasonable amount')
- Teachers' effectiveness as a teacher (15.8% and 42.1% as per above)
- Pupils' attitudes to physics (15.8% and 36.8%)
- Teachers' attitude to teaching physics (13.2% and 42.1%)
- The school as a whole (15.8% and 28.9%)
- Teachers' confidence levels in teaching physics (13.2% and 26.3%)
- Pupil learning (13.2% and 21.1%)
- Pupil performance (13.2% and 2.6%)
- Pupil post-16 uptake of physics (7.9% and 15.8%)

The data above indicates that mangers believe the impact has been stronger on the teachers, the department and the school (and on pupil attitudes to physics) than on pupil learning, performance and post-16 uptake. The impact on pupil performance and on pupil post-16 uptake of physics is mostly viewed by managers as moderate – this may be because often they don't yet have sufficient evidence for this, as respondents have commented in the open response boxes in the questionnaire (see appendix 3 for the open question responses of the CPD managers)

47.4% of the managers felt that action research was 'very useful' for classroom improvement and 44.4% felt it was 'quite useful'. 36.8% said they had plans about using their teachers' findings in future staff development. 60.5% would send other teachers on the course in the future and 86.8% would recommend the course to other senior managers.

Answers to open questions:

What is your understanding of the teacher's intervention and the impact it has had?

Raised profile of physics within faculty, especially at KS3. Resources have been used well to engage pupils and stimulate enthusiasm for physics

Research into motivating pupils in physics by developing coordinated cross-curricular programs of study. - Huge benefits in terms of motivation and enjoyment of physics. - benefits to teachers - having the creative freedom to work together on a common project.

-Has been researching the most effective ways of group-work. - Made big difference to teacher's confidence, self-esteem and enthusiasm for teaching physics. - Has had major impact into the way group-work is set up in lessons. -Has

benefited from working with other physics teachers. - Development of new T&L strategies.

The research was based on the uptake of girls in physics post-16. A range of activities were designed to increase awareness and interest of the cohort of girls including working with STEM Essex, this was also supported by the teacher exploring different teaching approaches including clear links to careers. The teacher's additional confidence in teaching physics was augmented through attending a 4 day course at the NSLC on physics for non-specialists, it also linked to a visit for the teacher to CERN. Teacher has contributed to published articles, conferences and school CPD, pupils have already benefited.

This teacher is leading intervention in science at our school. She has a great impact on intervention + strategies used within the classroom. Results show a positive improvement with intervention.

The project has accelerated his understanding and ability to deliver online learning in his classroom. Teacher has shared this with other colleagues in science and across the school, and also with parents.

Greater engagement with physics by the pupils because of the strategies employed

4.10 Links between teachers' and senior managers' views of impact and pupils' interest and perceived difficulty

Statistical comparisons have been made between teachers' indications of the impact of their interventions, their confidence levels in various areas after finishing the ARP Programme, their Senior Managers' sense of the impact of their interventions, and pupil interest levels and their experienced difficulty of physics.

As can be seen from table 22, the more the teachers' confidence has increased, the more interested their pupils are in physics. Of course the causality may be in the reverse direction.

Table 24. Pearson correlations between teacher variables and student interest in physics

	[Student] How interested in physics are you?
[Teacher] How has your confidence in teaching physics changed for you since you started the programme?	.075 (t<.05)
[Teacher] What is your general feeling about taking part in the Action Research for Physics Programme?	.0146 (t<.01)
[Teacher] How effective do you feel your participation in the Action Research for Physics Programme has been in increasing your pupils' engagement with physics?	.113 (t<.01)

Also, the more positive teachers feel about their participation in the programme, the more interested pupils are in physics – again, the causality of the link may be in the opposite direction.
There is a significant positive relationship between how effective teachers feel their participation in the programme has been in increasing pupil engagement with physics, and how interested pupils say they are in physics.
However, there is a negative correlation between the CPD managers' sense of impact of the teachers' participation in the programme on pupil attitudes to physics and the pupils' indication of their interest in physics at the end of the programme.

This is also the case for the extent to which senior managers feel the programme has affected the teachers' effectiveness as a teacher (see table 25):

Table 25. Pearson correlations between CPD managers' views about the impact of the course and student interest in physics

	[Student] How interested in physics are you?
[Senior managers] Please indicate the extent to which you feel the teacher's participation in the course has impacted on pupil attitudes to physics	-.0169 (t<.01)
[Senior managers] Please indicate the extent to which you feel the teacher's participation in the course has impacted on the teacher's effectiveness as a teacher	-.125 (t<.01)

There is however a positive correlation between the extent to which senior managers feel that the teacher's participation has impacted on pupil learning, and the likelihood of pupils to take physics post-16; but where teachers' confidence levels have increased as a result of the course, pupils' intentions to choose the subject after their GCSEs have decreased significantly (see table 26).

Table 26. Pearson correlations between CPD managers' views about the impact of the course and student intention to study physics post-16

	[Student] How likely are you to study physics after your GCSEs?
[Senior managers] Please indicate the extent to which you feel the teacher's participation in the course has impacted on pupil learning	.0179 (t<.01)
[Senior managers] Please indicate the extent to which you feel the teacher's participation in the course has impacted on the teacher's confidence levels in teaching physics	-.124 (t<.01)

4.11 Comparisons between the final pupil questionnaire and the control group (the 'Year Above' questionnaire)

In Spring 2010, pupil questionnaires were sent to teachers to give to the pupils who were at that time exactly a year above the group of the action research intervention, and who were otherwise as similar as possible (ability, qualification working towards, gender distribution, etc.). 656 questionnaires were completed and returned. Of these, the schools which later also completed and returned the final pupil questionnaires were selected (399 pupils). This control group questionnaires and the final intervention group questionnaires (pupil questionnaire 3) were compared. Independent t-tests were carried out across all of the variables of interest, with the following results (statistically significant at p<.05):

- A reduced level of experienced difficulty of physics (significant at t=.006)
- An increase in reported time for reflection in physics lessons (significant at t<.001)
- An increase in the likelihood for Post-16 physics uptake (significant at t<.001)

- An increase in pupil interest in physics (significant at t=.049)
- A decrease in experienced level of difficulty of the words/terms in physics lessons (significant at t=.003)
- A higher reported number of careers talks in physics, especially by science teachers (significant at t<.001)

This points to a clear and wide-spreading impact of teachers' action research projects for the intervention groups.

4.12 Summary of pupil focus group meetings prior to interventions

13 focus group meetings took place for this purpose in 4 different SLC regions, across the country. They lasted approximately 30 minutes and usually had 5-6 student respondents. The participating teachers were most helpful and organised in setting this up for the researchers. The purpose was data triangulation with the baseline pupil questionnaire and the questions were therefore the same as the ones asked in the questionnaire, though issues were probed more deeply where necessary. In appendix 3 an outline of questions can be found.
Below follows an overview of responses per question, with illustrating student quotes.

Pupils' interest in physics

Pupils' interest in physics, as revealed from the focus group meetings, was variable. Many pupils said that they were quite interested in physics, that physics is everywhere and thus important for their daily lives. A striking positive point made in most focus group meetings was that physics deals with unanswered questions; it is not common knowledge, we don't know everything about it yet. Many pupils find this fascinating. It makes physics stand out from the other sciences for some pupils. Below are some of the pupils' comments supporting these views:

> *I mainly find it the most interesting because it's the one that most…like Chemistry, we know lots about Chemistry and about Biology we know loads, but with Physics there is still bits of it that no-one knows. It is very interesting to work on that stuff.* (Year 10 boy in mixed ability experimental boys' group)
>
> *It is also when you learn about something that is really big, it gives you a slight form of self-accomplishment. Because you think "wow!" I know how the universe sort of works.* (Year 10 boy in mixed ability experimental boys' group)
>
> *I think most of it we don't already know, because I think in some of the other sciences we know a bit of it already. But we don't know much of it already in physics.* (Year 9 girl in high ability group)
>
> Interviewer*: And you, do you find physics interesting?*
> *Sometimes it is, because with physics you can't really see stuff, like with biology you can do photosynthesis and leaves and plants, but with physics it is sometimes interesting because it is not what you know already and you learn new stuff.* (Year 10 girl in mixed ability group)
>
> *I quite like it, it is my favourite science, I think. Because it is quite interesting, there is a lot going on with it at the moment with the collider thingy in Switzerland, the big-bang experiment, which is quite interesting.* (Year 10 girl in high ability group)
>
> Interviewer*: And why do you think physics is interesting?*

Because we learn about a variety of topics that can be to do with our daily lives (...) (Year 10 girl in mixed ability group – girls' school)

*I think it is interesting, because you learn a lot about how things work (...) (*idem*)*

Other pupils were less interested in physics, or felt that it was boring. Below are some of the reasons given for this.

Interviewer*: And when you feel that it is boring, what makes you feel that it is boring?*
Just sometimes there is not much content. Year 9 boy, high ability group

I think some things are quite easy to understand them and you get them straight away, but you keep going over different things to do with it, and you just lose interest. Year 9 girl, high ability group

I think it is interesting at first. But then, we are just sitting around in the classroom all day, we don't do many practicals, so it gets a bit boring. (Year 10 girl in mixed ability group)

Mostly we do the same things every year. And we just do them in a little bit more detail. But because we repeat them so much it is too repetitive. (Year 10 girl in mixed ability, single gender group)

We're not really interested in electricity. (Year 9 girl in high ability single gender group)

... but with physics it is always the power supply and then lots of wires and a batch of something... and it gets a bit tedious. (Year 9 girl in high ability single gender group)

Physics is more about like machines and stuff and I am not really interested in machines and how things work. (Year 9 girl in cross-section of abilities group)

Pupils' interest in physics compared to the other sciences

Preferences for three sciences varied, but some pupils find physics more interesting than chemistry and biology:

I think it is quite fun compared to chemistry and biology. Because it is more like, it is easy to get to grips with sort of thing, easy to follow along with (Year 10 boy in mixed ability group)

I think physics is more serious. Because it helps you explain the world around you and stuff (Year 10 high ability girl)

(...) Because like with chemistry and biology do a lot with past theories like Darwin, but with physics it is more like going forward. (Year 10 boy in high ability group)

I don't know, because in chemistry you do lots of like chemical reactions and I think physics is more about the world, so I think you have more physics in everyday life. Cause biology is about bodies and everything, so obviously that is quite important, but I think that physics is probably more important than chemistry in everyday life. (Year 9 girl in high ability group)

Physics topics that pupils find especially interesting

Space/the universe/the solar system stand out, and also renewable energy forms are mentioned a couple of times:

> With space you get to make your own decisions about what you think is going to happen. You don't know the answers and things. (Year 10 girl in mixed ability group)

> [Space] is easier to learn as well. It is more straightforward. (Year 10 girl in mixed ability group)

> I don't know, [space] is just more interesting cause we actually see it, but we learn about what we see - energy, it is just, we don't really see it. (Year 10 girl in mixed ability group)

> Yeah and it is interesting to think of your ideas and what you think happens - with circuits it is just, this is it, this is the end, it's boring. (Year 10 girl in mixed ability group)

> I quite like doing about energy. (Year 8 boy in mixed ability group)

> I quite like the wind turbines and how they work, I find that fascinating. I like learning about that (Year 8 boy in mixed ability group)

Physics topics that pupils find especially uninteresting

Circuits are mentioned very frequently as less interesting (boring) topic. This is caused by what pupils feel is an endless repetition of doing practicals with circuits, which they feel makes it very boring. The repetition makes them feel they are not learning anything new; they comment that it comes back in the same form year after year after year.

> I find that, once you learn how a circuit goes round, and then you do it again in year 7, and again in year 8, and by the time you get to year 9 they say to you, well this is how a circuit goes round, and you are like, well I know how a circuit goes round! We were taught that 5 years ago. (Year 10 girl in high ability group)

> Yeah, we've done so much in electricity it gets quite tedious. (Year 9 girl in high ability group)

Friction is also mentioned as a boring topic with a lot of repetition.

> [Friction] is just not very interesting to do, it cannot help you with much, in life. (Year 9 girl in high ability group)

> (...) when you have done friction quite a lot, it gets boring. (Year 9 boy in high ability group)

Practicals are generally very much enjoyed, and found helpful, in physics:

> [How interesting do you find physics?] Pretty interesting. It depends what the topic is about, what we are learning at that time. If it is something about frequency and stuff, it is not that interesting, but if it is about some practical stuff, it is good. Atoms and stuff, but in other stuff you can't really do a practical, which is not that good. (Year 10 boy in mixed ability group)

> Yeah. Practicals help. It's like, if it comes up in a test, you think like, oh, that's when we did that! So you can picture yourself doing it and you think so okay, so we did that and than that. And it's easier to remember. (Year 9 girl in mixed ability group)

Some pupils feel that there is a lot of repetition in classes:

> Beause in year 7, you're like learners, and then in year 8, you learn it again. (Year 9 girl in mixed ability group)
>
> It is a bit like, revising, and then revising, and then revising more again. And then you get like, more revising. (Year 9 boy in mixed ability group)
>
> Occasionally we do something different, well slightly different, well same sort of thing but we do something slightly different and we learn more about that, that's interesting, to find out about different aspects. (Year 9 boy in mixed ability group)

Difficulty of physics experienced by pupils

Mixed answers have been given to this question as well, but striking was that not many pupils found it that difficult. The equations and formulas (the maths aspect) are often mentioned as a difficult part of physics. As a result, some pupils find it the hardest of the sciences, usually because of the maths/formulas.
Concepts are sometimes mentioned as difficult, but this is often only initially, as pupils seem to feel that they seem more difficult than they are as they sound very scientific. Teachers' methods for them to learn the concepts are often mentioned and pupils comment that once they know them and have worked with them, they find it doable.
Some pupils feel that teachers can go too fast, that there is not always enough time to consider whether they have understood. They then end up discovering when they are revising for the test that they haven't understood, but by then it is too late. Others feel that they are not given the deeper explanations, how things work, or that with physics it is harder to 'see' things happening, which frustrates them:

> It is like *why* things happen, you don't always get told why things happen. I suppose if you went further you would be told why it happens, but at the moment we probably wouldn't understand it, so we are not told. And then it kind of confuses us, like, why is this happening. (Year 10 girl in high ability single gender group)
>
> Chemistry is easier to understand if you see it happening, if you see the reaction happening, whereas you can't really see everything in perspective with physics, and I think if that could be made easier to understand for younger children, then they would want to take it up and they would get more interested in.... I don't know! (Year 9 girl in high ability single gender group)
>
> It's like with electricity, they save it, it's like charges go through the wire or something. But you can never actually see the charges, you never actually see them properly, so you just have to assume that that's... (Year 9 girl in high ability group)

Some pupils find physics the hardest of the sciences:

> I don't find it more difficult but I think it needs a lot more explaining for you to understand it, because for example if you are working out frequency you have to change the formula to make it work again. (Year 10 girl in mixed ability group)
>
> In an exam, I find physics harder to understand, like the questions, because they are really complex and they use big words and stuff. But with chemistry and biology it is easier, in biology you kind of know, because it is about the body and it is more like common knowledge. (Year 10 girl in mixed ability group)

Furthermore, pupils feel that there is a lot to know and remember. Some of them also indicate that it makes a big difference whether a teacher is specialised in physics, in which case they feel they are given better explanations.

Difficulty of physics compared to the other sciences as experienced by pupils

A recurring comment is that physics is less spread in topics, it is more together; the same principles apply to everything. A consequence of this is that less memorising is required, there are not so many different things linking in with any one topic which they feel is the case with chemistry, and this makes it easier for them. Some others feel it's the other way around, as can be seen below:

> It is more like a general thing, like you don't go into details, like in chemistry you have like a subject but you go into detail into each separate bit of the subject, whereas physics, the subject is like a whole, if you get what I mean? (Year 10 girl in mixed ability group)
>
> With chemistry it is just so much simpler, it is not like there is a great big concept behind the rule or anything. (Year 9 girl in high ability group)
>
> I think it is more difficult! Because in physics there is more calculations and stuff to do and working out speed/distance and so I think it is quite difficult at times. (Year 10 girl in mixed ability group)
>
> And you have got to remember how to balance things out and things like that in chemistry. And in biology you have to remember all the different cell structures, that kind of stuff. Physics is more obvious, you can see it. (Year 10 girl in mixed ability group)

How difficult do pupils find the words/terms used in physics lessons?

Generally the concepts used in physics are not seen as very difficult; also teachers seem to have developed many strategies to familiarise pupils with the concepts early on. Pupils sometimes find then daunting initially, because they sound 'scientific', but once they know what they mean, pupils seem to find them a lot easier than how they initially sounded.

It depends on how they explain it to you. They just give you all scientific words and stuff. But depending on the teacher you are given, they might explain it like, this can cause this, instead of just giving you everything straight away and expecting you to already know it. (Year 9 boy in mixed ability group)

I forgot one now, it is so difficult I can't remember it. And there are some words as well, if you ask the teacher what they mean, it is like, easy, but they made it just like sound that scientific. (Year 8 boy in mixed ability group)

There are some confusable ones, like velocity, you can get confused. But once you understand it is kind of easy, but I haven't really found many words difficult this year so far. (Year 10 girl in mixed ability group)

I think the more you go over them and learn stuff about them, the more they become easier to use and you understand them more. (Year 10 girl in mixed ability group)

I think that once you have understood what you are meant to be doing then it is a lot easier, but it is just the understanding part that is the hardest. (Year 10 girl in high ability single gender group)

In what way do you think physics is relevant to your everyday life?

Many pupils find it very relevant, say it is everywhere, they use it all the time. Global warming is often mentioned in this context. There are a few pupils in each group who don’t find it relevant at all, they don’t think they need to know about it, they can just make use of it without understanding how it works.

Physics relates more to everything. You can use physics later in life but with maths, you learn stuff that you will never use again but physics, you know, it pops up in life. (Year 10 boy in high ability group)

I think when we learned about rays, like sun bed rays, we know what cautions to take when we are using them, if we use them in future. And we did this thing about what kind of sun cream to put on, so we can use that when we go to a warm country. (Year 10 girl in mixed ability group)

I think it is related, but I don't really use physics. I think until you are older and you start like monitoring your electricity bills, changing things in your car and stuff, you don't really need it. (Year 10 girl in high ability single gender group)

You kind of need to know physics for your general everyday life, because with electricity you kind of have to know what happens and stuff (Year 9 girl in high ability single gender group)

Well at our age, it is not really very important for us (Year 9 girl in high ability single gender group)

To me it is very much like passing your exams in physics rather than this will help you in the future kind of thing. (Year 9 girl in high ability single gender group)

Yeah because I don't really think physics has that much relevance for your daily life. I mean you use electricity every day, but you don't really need to know about it to use it. It is just like, turn the switch on and it is working. (Year 10 girl in high ability single gender group)

Yeah, you can see what it can cause, like global warming and stuff. See the causes of it and what you can do to stop it. (Year 9 boy in mixed ability group)

And by learning about forces and stuff, that is really important in your everyday life. (Year 9 girl in mixed ability group)

I think if you want a job in it, say you would like to become an engineer or something, you'd want to be more qualified in it, so it is important in that kind of way but if you are not going to do anything with it you are not going to need to learn it in much detail. You can just learn the basics. (Year 10 girl in mixed ability group)

In your physics lessons, how often is physics linked to other subjects; your everyday life?; worldwide issues?

Links to other subjects: if made, then pupils feel this is usually to maths and other sciences; some say geography. Some pupils say it would be very beneficial if it was linked to every(!) subject – sports is given as example; music. Others don't see the point in that.
Everyday life and worldwide-issues: pupils often say it can't be linked enough in this sense. Some stress the importance of spending time on theory as well, a good balance between the two.

[Interviewer: Do you feel physics is linked to other subjects?] Maths, a lot. And with some of the stuff we do in chemistry as well, like atoms and stuff that we've been doing. Cos chemistry is more about the structure of the atoms but that helps you understand what atoms do, radioactivity and all that. (Year 10 girl in high ability group)

Well, we sometimes link it to geography. Topics like waves and stuff, we do that in physics AND in geography. And it quite relates to other subjects such as biology and chemistry sometimes. (Year 10 girl in mixed ability single gender group)

It links with maths, like, science in general fits with maths together, working with numbers, but besides that I don't really think it links to anything else. (Year 8 boy in cross-section group)

Maybe it links to PE, but everything else it would be alright with, because if we linked it to every lesson it would seem like we were doing physics in every lesson. The kids are going to understand it more. (Year 8 boy in cross-section group)

If you step back into year 9 when we were doing electricity and things like that, that was very related to the outside world. Because even out of subjects we are doing at the moment, radioactivity etc, etc, etc, they aren't really feasible to bring into the classroom. (Year 10 boy in high ability single gender group)

[Interviewer: OK, and do you feel that in your physics classes, we talked a little bit about your everyday life, but do you feel that it is linked to worldwide things, things that are going on in the world.] No. Not really. They say in chemistry, oh, we're causing pollution for Sweden or Norway, because of our factories and that, but they don't say: physics, I don't know, the construction of the Eiffel tower was done with physics or whatever. They just focus on the subject really. And what happens and stuff. (Year 9 girl in mixed ability group)

How likely are you to study physics after your GCSEs?

Quite hesitant responses were given to this question generally, especially from girls. Boys are often inclined to take it out of interest; girls only when they need it, they often prefer the other sciences more. They do often find it an interesting subject but it doesn’t take priority in their options unless they need it for further studies. Reasons given for taking physics post-16 are the following:

- Because it helps with other subjects
- Depends on what I need
- Encouraged by brother or sister
- Important subject to take
- Inclined not to take up because difficult or not understanding
- Inclined to take up because of understanding
- Info given about what to expect
- Interested in taking physics to A level
- Marks are an issue
- More inclined to take up other science to AS
- More interested than taking up other sciences
- Need it for career
- Need other sciences more than physics
- Not interested in taking up physics to A level
- Not sure

Are you interested in a career involving physics ?

Many pupils are contemplating a medical career (often girls), but physics is not needed at every university for this, so not all intend to take physics. Some pupils want to become architects, of whom most, but not all, realise that physics is needed/relevant for that.

> There aren't any like obvious jobs that use physics that people want. (Year 10 girl in mixed ability, single gender group)
>
> Yeah, because they just want to do medicine or banking and for those applied things physics is not essential. So it is just going to be one or two people. (Year 10 girl in mixed ability, single gender group)
>
> Well we don't really know what kind of career you can do with it. (Year 9 girl in high ability, single gender group)
>
> I think in physics there isn't like a set job that uses everything that there is in physics; there are quite a lot of quite specific different topics in physics in which you have different jobs. So quite often you don't need to necessarily know everything from physics, like xx said, like a separate topic of electricity, or... (Year 9 girl in high ability, single gender group)
>
> [Interviewer: What are the kinds of careers that come to mind when you think about physics?] Not a lot really. I just think of physics teacher and that's about it. I always think about simple making experiments in labs. I can imagine it being quite fun if you were just exploring different things about it. As a job that would be quite good. Spaceman! (year 10 boys in mixed ability single gender group responding)
>
> Many don’t know yet what they want to do. Don’t have a clear idea at all about what you can do with physics apart from obvious jobs. (Year 9 girl in high ability, single-sex group)
>
> I don't know what you can do with it really. Besides being an electrician and a plumber and stuff like that. (Year 8 boy in mixed ability group)

Physics is considering by some pupils to be an important subject for your further career, whether you continue with it after GCSE or not:

I think quite a lot of people will take it because it is just something new to do. And it like, looks good, if you went for a job, if you have a GCSE in physics or an A level in it. So it might just be because of that. (Year 9 boy in high ability group)

I like physics the most. Because it is the hardest one, and if you are good at that, it is better than the other ones, so you can get a better job if you are good at physics. (Year 8 girl in mixed ability group)

I think also that if you've got a degree in physics and stuff on your CV it will make you look like, jobs are much likelier to get. (Year 10 boy in high ability group)

Has anyone ever talked to you about careers in physics?

Most groups say this is hardly mentioned in class and that they don't have much of an idea what you can do with physics. All feel that it would be hugely beneficial, in terms of how much more interesting it would make physics and how much more they would see the relevance of it, and to know about what they would be good at, and what options there are.

I am not really sure about that many careers in physics, I think, cause I don't think [the teacher] mentions them that much, it is more like learning, learning, learning, and what do I need it for? But [the teacher] just mentions about going to university and doing physics was really fun, but I think [..] mentioned actual careers really only a few times. (Year 10 girl in high ability, single gender group)

Well, it would teach us a wider range of what we can do with physics, whereas now we don't really know anything apart from the obvious jobs. We would have to do a lot of research ourselves, so if they showed us more interesting things that people wouldn't immediately think of as jobs, then we may be more encouraged to take physics if we want one of those jobs, but because we don't know what they are, we don't really know what they are we don't really have that push to get that. (Year 10 girl in high ability, single gender group)

It could just give you an extra idea like what you would be good at when you get older. (...) Make it interesting, or maybe make you interested in this job. Maybe you are interested in this job, but you didn't know that it had anything to do with physics. If you say that then you would want to be really good at physics and improve your learning. (Year 8 boy in mixed ability group)

... we sort of dive into the basics of it and then go into the more extremes of it. Like you might have, during the work, you might have someone's career in it mentioned if it is relevant to work, but you don't get explained what jobs it's in. (Year 10 boy in mixed ability group)

Do you feel that your physics lessons are aimed: more at boys/more at girls/the same at girls and boys?

All pupils talked to seemed to feel that *classes* are aimed at both genders. Many said they don't think about it, teachers address questions to both genders equally, take both male and female volunteers for experiments. Some boys say that girls are often the quickest in finishing with tasks.

> I think they focus on people who are more interested, like if someone would ask a question off the syllabus, they would focus more on that person. And then help them more to understand it. Because if they're asking questions off the syllabus they might be more interested to go into it after GCSE and further studies. (Year 10 boy in mixed ability group)
> Well, I think if you think about it in the long term, in terms of jobs, I think it is more for men. But in classes it is for both. (Year 9 girl in mixed ability group)

One girl gives an example of how her classes are sometimes more aimed at girls:

> And because it is a girls' school, miss normally uses examples that relate to us, so she will be talking about something like hair straighteners or something, but she probably wouldn't do that in a boys school! (Year 10 girl in mixed ability single girls group)

Do you feel that physics or a career involving physics generally is more for girls/more for boys/no difference?

Many boys feel that physics is for both genders and seem to even feel a little insulted that it would be more for men! They feel it depends on interest and capability and there is no reason to think that this would apply less to girls. Physics is for clever people says one boy, indicating that gender is irrelevant, but that you just need to be very smart.
Some boys do indicate that boys are generally more interested in finding out how things work than girls and girls tend to be more interested in arts etc.

Girls are much more hesitant: they feel that it is a men's world and are not eager to enter it if there are few women there. Messages from home don't seem to always be clearly that girls can do this just as well as boys. But almost every group has a girl in it who has already decided she wants to go into physics. Many girls also state that they want to know how things work. In one girls' school, girls don't express any issues with going into physics, the comparisons with boys' capability and interest isn't there so it is just another subject that they can go into if they want. In the other girls' school however, very stereotyped views are expressed.

> I think with physics everyone assumes that it is more of a boys' subject, which I know sounds very, very sexist, but I think that is what everyone assumes. (Year 9 girl in high ability, single gender group)

> [I see it as a men's subject, because]... you see kind of men in kind of those dirty overalls with oil all over them. (Year 9 girl in high ability, single gender group)

> [Working in an environmental job] is like neutral gender, because I can see a woman or a man doing that. (Year 9 girl in high ability, single gender group)

> Science as a whole is boys and girls I would say now. (Year 10 boy in high ability group)

> I think it is only the application of science which differs. Say chemistry, if you take it to cosmetics or something, I think it is how you use science that is perceived male or female. But science being taught is for learners. (Year 10 boy in high ability group)

> I find it more for boys, because it is more astronaut and space stuff and that is more boys' stuff. (...) I think it is because, when you are a child, girls all want to play with Barbie dolls and stuff and boys just want to play with cars and then you kind of grow up thinking like that, but then when you see this women's astronaut stuff, you see like they are for both, but you don't really want to go in there because there won't be as many women there, so I find it more difficult to work with men sometimes. (...) the first person on the moon was a man, so men are like, they think they can achieve more... (Year 10 girl in mixed ability group)

> I think it is the same, because it gives [the girls] choices as well. It doesn't really limit them to say you can't do that, it gives them the choice that they if they want to do it, they can, it's up to them. So yeah, I think it is the same. (...) We are more interested in it, because we want to know how stuff works and stuff. But it depends on what you actually want to do. But it doesn't really matter if you are a boy or girl, it's the same. (Year 10 boy in high ability group)

How much time is there in physics lessons for discussion?

In many pupils' classes it is felt there is quite a lot of time for discussion, in some classes not much. Sometimes two groups from the same class describe contrasting situations with regards to this! Many pupils would prefer even more discussion because it helps them understand, see the relevance of physics, and keeps them interested, but they are also concerned sometimes that it shouldn't come into the way of recapping and making sure they have understood what they have done (i.e. reading and writing down summaries).

> I think that when she says, talk about it, everyone just talks about their own thing. That they don't talk about the work, they just talk about boys and stuff. (Year 10 girl in mixed ability group)

> [Interviewer: Are you saying it would be important for you to have more discussion? Have more time to discuss what you are doing?] Yeah, because then you will understand it more. (Year 10 girl in mixed ability group)

> Interviewer: [...] So what happens in this class that makes it easier to understand? I think because we can discuss. If we are not sure about something we are free to discuss it. Rather than in chemistry where they are expecting you to know everything. And to be silent. (Year 9 girls in mixed ability group)

> Interviewer: Do you like that, or would you like to see less of it? Yeah, it's easier for learning. Because the more you discuss things, the more it imprints in your mind. You lose focus because you get bored of writing after a while. And then you can understand it. But sometimes, like I said earlier, it just goes off on a tangent and you end up talking about something that is completely irrelevant and you think like 'Oh', right at the end of it. It can hinder some of the lessons. (Year 10 mixed ability boys in single gender group)

How much time is there in physics lessons to think things through properly?

Some pupils are concerned that there isn't enough time to think in classes and that it is left for them to do when they are on their own, doing homework, or worse, revision before the test. Many say though that they can always come back to the teacher the next day with questions. Some indicate that the teacher communicates that there isn't time for many questions. Many also feel that you think as you go along and that extra time is not needed for this, or would even be a little strange (what would we do, just sit quietly and think?)

> I think you might need a bit more time to thinks things through, like make your brain understand how things work. That would help. Yeah, cause the teacher is always rushing to kind of cover all the topics and learn us everything, but it is not really going into our heads, it's just... (Year 10 girls in mixed ability group)

> Thinking time? We don't generally get to just, sit and think. (Year 9 boy in mixed ability group)

> (...) you never know what everyone is thinking about, one person could just be thinking...and another one could be thinking: oh, I love physics, and then there is just a complete variation. (Year 10 mixed ability boy in single gender group)

> We think as we go along, really, I don't know, there is not really like, thinking TIME, we just do it. (Year 10 girl in mixed ability group)

> It is only at the end of a topic when you are revising, that you sort of get to know it a bit more than before. Because they are mixing up the lesson, you are getting your head around one thing and they are teaching you something else, so you need like a revising lesson after a couple of weeks of doing something. (Year 8 boy in high ability group)

Any other comments about physics / physics lessons?

Practicals are very much enjoyed and seen as hugely important. Most pupils feel that there aren't enough practicals.

Many pupils feel that they should be taken out of the classroom more instead of just sitting in lessons all the time. Activities around the school, but also physics trips are much desired. It brings physics alive for them and caters for different learning styles. They feel it helps them understand and remember and see what you can do with physics, how it is relevant.

Some pupils indicate that they pick up on it when the subject isn't the teacher's specialism and it affects their motivation; in one group there were comments made about this.

There are comments made about having the sciences as combined or separate – some pupils clearly express the wish to have separated the sciences earlier; others feel happier with combined sciences:

> I think [combined sciences] does help because you help because you have a different variety. You see someone taking more interest in something that you don't like. So you get to see different opinions and a wider variety. If you are doing physics and chemistry and biology separately, you might not like biology as much so you just might turn off almost, whereas if you are in combined science, you will have the same teacher but they will know that you take more interest in physics and chemistry, so they could help. (Year 10 boy in high ability group)

> I think [splitting the sciences earlier] would have helped and plus I think you would have understood it more, because everything was just bunched up together and [the teacher] didn't focus on physics as much as on biology. You spent most term on biology experiments. And it depends a lot on what the teacher likes to do. (Year 10 girl in high ability group)

> The only thing is that I wish we could have split it earlier. I wish we could have done biology, physics and chemistry in year 5. (Year 10 boy in high ability group)

General observations from the focus group meetings are that no clear differences between high ability (able/G&T) and cross-section groups were seen – sometimes the able group was more inspired, sometimes they were much more quiet. The girls' groups were very different from each other - in some very stereotyped opinions were expressed; in other girls' groups the girls were much more confident, interested and emancipated'. Girls' behaviour in mixed groups varies a lot, sometimes they were very quiet and unconfident to speak up, letting boys speak; in other groups they could be assertive and leading, and much more articulate.

Generally, it can be seen from the focus group meetings that opinions vary widely. The meetings were a very useful and in-depth addition to the questionnaire responses. There don't seem to be clear contradictions; they just give a vast body of additional information about reasons why pupils feel in particular ways and their opinions about what happens in classes.

4.13 Summary of pupil focus group meetings (post-intervention)

These focus group meetings were carried out from November 2010 until February 2011. Mixed gender schools, with Year 11 pupils at time of second meeting (same pupils as before)
Initially the pupils didn't report any changes, but later on they did say they felt there had been a positive difference although they couldn't quite put the finger on what this was (and they felt very positively about their classes anyway). The more visually oriented materials used recently they found very helpful and they also felt that the classes were made to be even more relevant to the world outside and to careers than before.

Many of them said they like practicals, hands-on stuff, but some felt concerned, being close to their exams, about time taken up by practicals. This was in response to the question as to what they are particularly interested in in physics at the moment.

> There is no difference, I enjoy it still. But I enjoy it a lot more than the other 2 sciences. And I enjoy it more but I can't <u>see</u> a difference. (Year 11 boy, medium ability group)
>
> I feel the same as before, I don't enjoy it but I don't hate it. It is quite a confusing subject for me, equally confusing now as before. (Girl, Year 11, medium ability group)
>
> I don't see a difference in the teacher's methods but our enthusiasm is greater because of the upcoming exams – we really want to understand it now. We are more switched on. (Boy, year 10, medium ability group)
>
> The teacher uses more visuals, whiteboards, less bookwork. A lot more talking, asking questions. A lot more moving diagrams, which are very useful. (boy, year 10, medium ability group)
>
> Physics is quite complicated because of equations etc. Visuals have made it easier, showing what happens (boy, year 10, medium ability group)
>
> There are lots of everyday life examples, you don't get that in other subjects. She has always done that though, the classes are geared to help us see. (boy, year 10, medium ability group)

No changes in post-16 study intentions reported – pupils say they have the same ideas as before, for some it depends on what they need and the grade they will get. A stronger focus on careers is reported with more events ('Fantastic Plastic'; a Science Road Show).

Mixed gender school, Year 11 pupils, originally two separate focus group meetings (one all-boys' group) but now merged into one

The participating pupils initially reported no change to all the questions about this they were asked. They felt equally interested and motivated, found physics equally difficult/easy, and had the same career ideas as before. They were informed at the beginning of the meeting that because of the course their teacher had made changes to their classes, and were only informed about the specific intervention of the teacher at a later stage (as agreed with the teacher) when one of them asked what the teacher had changed. They then realised and remembered this change (it turned out it had been before the summer holidays) and commented upon the actual intervention. The 'no hands-up' policy which was used they felt worked because they were more alert, but on the other hand they were also more nervous so they found it less pleasant. The small whiteboards they liked (some girls mentioned that explicitly) because they can scribble their answer, wipe it out if they're not happy, it doesn't have to be perfect straight away.
The pupils in this group are generally very motivated and interested in physics. They felt that links to everyday life were often made in classes but that they themselves make the links in classes anyway. They reported a lot of discussion but this wasn't any different from the baseline focus group meeting. The same applies to the gender focus in lessons – they felt on both occasions that lessons are aimed at both boys and girls.

Mixed gender school, Year 10 pupils doing triple physics

The pupils in these groups were generally very enthusiastic about physics because they felt the teacher was very inspiring.

Pupils said their teacher is very enthusiastic and that this rubs off on them; also physics is made very relevant for them and constantly linked to everyday life in classes. Many said they would like to take physics post-16 and some would like a career involving physics.

> I don't like physics, but the teacher makes it more interesting (girl, Year 10, high ability group)
>
> What we learn is quite dull, power stations etc. (Girl, Year 10, high ability group)
>
> The universe is quite interesting though (boy, Year 10, high ability group)
>
> Links about our daily lives I see, but why do we need to just learn about things like that? I am not interested in that (girl, Year 10, high ability group)
>
> Biology is more linked with life, like animals (girl, Year 10, high ability group)
>
> I don't know how it is going to help me when I get older (girl, Year 10, high ability group)
>
> Lots of it blows your mind (boy, Year 10, high ability group)

I would like to be a physicist; I am interested in the philosophy (boy, Year 10, high ability group)

You can do more at a lower level with Chemistry and Biology than with Physics, but with Physics you can do more later on (boy, Year 10, high ability group)

Whether I take physics or not depends on how difficult it will get at A level (boy, Year 10, high ability group)

I want a science related career so I will choose as many sciences as possible (boy, Year 10, high ability group)

There is a lot more discussion, sometimes completely off the subject, which he did before. He tries to make it as interesting as possible; he'll go off the subject to make you understand. But then in the last 5 minutes we need to write it all down, in a rush. But we haven't had the normal lessons very long before the changes. (Girl, Year 10 high ability group)

There is so much, it is hard to cover everything, so discussion helps with that, but for me it doesn't really stay in (girl, year 10 high ability group)

I don't know really what you can do with physics. In Year 9 he listed jobs in physics, but this year not really. Maybe it was to get us to choose triple physics. I don't want to realise later that I need it! (Girl, Year 10 high ability group)

Mixed-gender school, Year 11 pupils

Pupils in this group felt quite negative about their physics classes and indicated that they mostly did textbook work. They didn't feel the teachers did a lot to make it interesting and relevant for them. The interviewer knew about some out of class physics events the teacher had undertaken as part of the intervention and asked the pupils about their feelings about these. They expressed enthusiasm about them but there didn't seem to be a link between these events and their classroom experiences.

They also reported more careers talks, outside of classes, in the form of presentations, but not as part of classes. Any changes reported are that pupils feel it has become worse, more rushing through the textbook.

It's like 'Get this done', like 'That's my job done, they've learnt it', but often you read it and you don't take it in, especially if you're a kinaesthetic learner. They don't care if you get it or not. But you just don't take it in. (Girl, Year 10, high ability group)

Electricity hasn't improved. We're in top set and we're doing primary school stuff. (Boy, Year 10, high ability group)

Whether I will take it depends on what's included in the course, if it is more of the same, then no. I am less interested in taking it now than before. I would like to do more astronomy, but that is not in the AS syllabus (Boy, Year 10, high ability group)

I might now take it because of my results, and I am encouraged to choose it because of that. I don't like it. I don't think it is right, but it is part of life. (Girl, Year 10, high ability group)

They don't care about what we like, let alone take into account gender (girl, Year 10, high ability group)

Pupils in this group also didn't feel that many links were made in classes with everyday life, other subjects, worldwide issues, except with maths. They felt it was more interesting at the time of the Hadron collider, but nothing like that is happening at the moment, they said. They also reported that they have no discussion and thinking time:

> Teachers set up debates but it is not a real debate – they just go through the different opinions. We don't have time to stop and think, we just move on. But it would be useful. It's got less. (girl, Year 10, high ability group)

Girls' school, Year 11 pupils, triple physics

The pupils in this group were quite enthusiastic but not clearly more enthusiastic/motivated than before (they were very positive already before the intervention). There was no clear indication that they had realised what the intervention was, but made some references to links with everyday life being made in classes, although these had been made as well in the previous focus group meeting.

> I am quite interested and I am more interested because I'll take it next year – we have recently chosen options. I like finding out why things happen. I don't think I was planning on choosing it before! (Girl, year 11 high ability group)

> I was going to take it but not anymore. The contact at AS level is not as interesting as in GCSE, i.e. a lot of mechanics. I prefer the universe. (Girl, year 11 high ability group)

> It is interesting – it is hard, but rewarding when you get it. I won't take it because I don't think I'll cope, it takes too long to understand it. (Girl, year 11 high ability group)

> Physics is different from anything else, in a good way – finding out how things work. (Girl, year 11 high ability group)

> I enjoy it more now, I don't know why. Maybe the topics, stars etc, not just motion. (Girl, year 11 high ability group)

> There is more depth now in the subject, it is more interesting, you get it more (girl, year 11 high ability group)

> More links to everyday life are being made in classes, which makes it more interesting. Past topics were more equations, now it is more about the universe. (Girl, year 11 high ability group)

> It is still hard, it is hard to accept things without knowing why (girl, year 11 high ability group)

> How difficult it is varies more now across topics (girl, year 11 high ability group)

> Stars and lenses are interesting. The lenses have good practicals, a new type – electricity practicals were boring (girl, year 11 high ability group)

> Circuits and momentum are boring – with circuits there is no change in what we do and momentum is stupid, apart from how cars are made, which is useful (girl, year 11 high ability group)

> It is very useful to know how to rewire a plug (girl, year 11 high ability group)

> The more you think about it, the more relevant it is, but initially you think probably biology is more relevant (girl, year 11 high ability group)

> The other sciences are more interactive, you can change things more in experiments, with physics you just learn stuff (girl, year 11 high ability group)

> I won't take it because it will be harder than now and I find it hard already. I don't think I have the motivation – I am not interested enough (girl, year 11 high ability group)
>
> I am interested in it and will take it, even though I am getting increasingly worried, but I think I can cope
>
> It's like uncoding a new language; I don't think I'll be able to cope (girl, year 11 high ability group)
>
> I need maths or physics for medicine, but I will get a better mark for maths so I will probably choose that (girl, year 11 high ability group)
>
> Physics aimed at both genders, it's a wide subject. Although examples are probably more aimed at boys. The textbooks are more directed at boys – lots of examples with cars, but the teacher balances it with examples for girls. (Girl, year 11 high ability group)
>
> It is not linked with worldwide issues very much, except energy/sustainability/global warming, but we do that ourselves (girl, year 11 high ability group)
>
> Links are not important for exams! (Girl, year 11 high ability group)
>
> I have to do the thinking at home, there is too much in the syllabus. I would rather have more thinking time than discussion time. (Girl, year 11 high ability group)
>
> I would like more interesting experiments – they help me learn and remember. They should be a bit more sensational as well; they're too simple and ordinary and not challenging enough (girl, year 11 high ability group)

Careers talks are reported not to happen more often than before, they only take place when it comes up.

The words are not found very difficult by the pupils in this group.

Generally, there are some positive changes reported in some groups, but students cannot clearly point out what they are in these cases. In many groups there seems to be a greater enthusiasm about physics but this is a purely subjective feeling of the interviewer.

4.14 Summary of Teacher Focus Group Meetings

At the end of the 3rd professional development session at the Science Learning Centres, a focus group meetings with volunteering delegates was held about their experiences of the course and the impact of their participation and their action research intervention. To retain as many delegates as possible, the meetings were made part of the programme for the day. Due to snowy weather conditions at some SLCs there were only few participants in some groups, but in most groups the number of teachers present was between 6-10. Below follows an overview of responses, illustrated by quotes from delegates.

4.14.1 Usefulness of the course

Most useful

- Most often mentioned are being able to meet other teachers, share and “steal” ideas, hearing about others’ interventions in their particular school background and hearing about their issues; getting useful ideas and things to try; a chance to speak to people who also want to change their practice
- “It made me focus on what physics teaching is about”
- “It made me think about what physics means in terms of everyday life and careers”
- Time out for reflection about our teaching and classes, develop our thinking
- Time out of the daily “humdrum” of the school
- Exploring a particular issue; having a chance to do things you know you should do but you never have the time, but now you make the time; “It prompted/pushed me to do something I have really enjoyed doing”
- “Having a good reason to change something, and change only *one* thing, follow it through rigorously, testing it, justifying it to others. Getting feedback that it was because of what you did”; “focusing on only one aspect has made a big difference to me”
- Several delegates also said that it was nice to be able to try something and it didn’t matter if it really worked; normally they wouldn’t then go back, but this time they reflected on it and changed it
- “We always get so much thrown at us by the government etc, you have to try this and that, but now we can do something that actually works, and also we can say: actually I am doing action research, so no!”
- It was great to get feedback from other places as well, I showed this to my senior management and they now take it more seriously
- Because you’re forced to collect evidence, you have something to show which is taken seriously – issues and outcomes.
- “I have been really inspired by the presentations of other delegates and keen to try them out”
- It was nice to have the support when you were stuck with your intervention
- It has helped me view my lessons from the point of view of the pupils and their experiences
- Showing pupils that we are trying to base things around them; they quite appreciative that we are listening to them
- “the typical response from colleagues when you are doing CPD is that it must be very dull, but in this case it is not like that at all – it is teacher pampering actually!”
- “Often in CPD, you are spoken *at*, even when the topic is interactive learning for example and you think: ‘*Please* do it with me!’ But in this case it is very different, there is a lot of sharing and interaction and you are not talked *at* at all”
- “The fact that I was forced to engage with the research by having agreed to come on the course. This made me look at my practice and think about what ways I could improve it, which I might not otherwise have done.”
- Using questionnaires with the kids which allowed me to find out things that I was really surprised about, like they knew very little about physics careers and the contexts in which physics occurs in their everyday lives.

- Several comments about having the time (during the CPD days) to reflect on practice and plan, outside school and with the opportunity to discuss with other practitioners
- The Southampton pupil questionnaire came up with some answers I was really surprised about, so it gave me the opportunity to ask questions of the kids I would not otherwise have asked. It also then gave me ideas about the best strategy to use in my action research – in my case about giving the kids more careers information. It also made me find out more about careers related to physics, which I found I didn't know a lot about.
- The girls' stuff was really useful, language used, difference between boys and girls.
- The reflection of myself and my pupils, why physics, what we need to do, what works well.
- Contacts with university were especially helpful, they helped me set up a videoconference with some of their staff for my pupils. And they helped me to get the information I needed.
- It allowed me to prioritise something that I knew needed doing.
- I enjoyed collaborating with other departments, schools, organisations, STEMNET. That was really interesting and increased impact.
- It was nice to concentrate on doing something different in the classroom.
- The classroom visits from course tutors were very useful

To summarise, what was found most useful about the course was the meeting with and sharing of ideas with other teachers; taking time out of school to reflect on teaching; having the chance to focus on / study one particular aspect of one's teaching and following it through rigorously; unexpected (informative) outcomes of student surveys and interviews.

Least useful

- "Nothing!" some said
- Most delegates indicated that a longer period of time to carry out action research would have been better. The programme was originally scheduled with an 18 month duration, but with a delayed start for many SLCs and a fixed end to the programme, this came down to 15 months;
- It also took delegates a couple of months to work out the topic of their action research intervention (one teacher said that by that time, the pupil had already done a lot of physics). It was felt to be difficult to change something in that short period of time and also get the results of your intervention, and also by some that there was not much time getting qualitative data. " I would have liked to go on longer, for pupils to reflect on what we have done and for me to put a few more things into practice"
- An additional problem was that the programme was stretched out over 2 academic years which for some teachers gave problems with continuity due to changing classes (although it seems that most teachers prepared for this and made sure that they did their intervention with a group that they would carry on with after the summer)
- Many teachers would have liked a 4^{th} professional development session as follow up.
- Some teachers indicated that they would have liked to start more quickly, even start before the summer so that they were ready after the summer to

start with their action research interventions; one teacher wished that he could have had the information about action research of the 1st professional development episode before it started, so that have would have started on the right foot (he did not include a control group initially and when he discovered this was desirable, it was a bit too late for that)

- Some felt the 3 CPD meetings were too spaced out, they would have liked more follow-up
- Some even request 6 professional development sessions, stretched out over 3-4 years so that the research could be done more thoroughly and more conclusively
- Delegates often feel that now it feels “disjointed”: they are still in the middle of something and they would like to continue (many have indicated that they will continue)
- Some delegates indicate that they feel the time scale was realistic
- One delegate said that more funding would have been useful because it is not effective to the use of money if it stops now, it will be much more effective to the wider community with more money. Another teacher said that it should be made amendatory for schools to spend the money in the science department, as delegates in some schools never saw the money again.
- “It would have been nice to hear from teachers outside the SLC geographical region as well”
- One delegate felt that the evaluator’s questionnaires were “an overkill”; they came on top of his own and the pupils got fed up with filling them in, and with the later ones, might not have answered questions very seriously anymore
- Some delegates would have liked to have a bit more one-to-one guidance, about action research, and in the middle of the programme, to guide them into directions, help with the case studies
- In one SLC, in which the course tutor was based in the school of 3 other participants, the rest of the delegates would have liked him to come and visit them in their schools as well as a useful addition.
- Other comments: it is a long way away, getting childcare and looking after your classes while you’re away can be difficult
- It wasn’t what I expected it to be about – I was expecting a course which gave me more strategies for teaching physics (I am not a physics specialist) but obviously it was not about that. It did give me ideas I didn’t have before, and was useful, but not in the way I had originally understood (2 people)
- Finding the time, working around the normal workload was most challenging
- I went off in the wrong direction, I would have liked more direction at the beginning
- I would have liked clearer guidance, more communication and collaboration at different stages – where am I?
- The timeframe was unrealistic – advertised as 2 years but after approval of topic really only one year

Generally what was found least useful was the short time span and the timing of the course, sometimes a felt need for more (and earlier) one-to-one support.

Major effects of action research interventions on pupils

- Pupils became very aware of the role physics plays in their lives and they are now interested in the subject, the enthusiasm is there, so I can just set them tasks now and they will do it. All are on the same page now, all are passionate
- Pupils are engaging with it more, and more likely to take it further
- More time for them to reflect as this was one of the things they asked to have following the 1st questionnaire.
- They now come into the class keen to know what they are doing this lesson. Before, they weren't exactly asleep but they were much less interested. Now they are really keen. The present class I am still having to work on, as they are not used to my intervention. The pupils from last year still in my class know what to expect and I haven't yet got the pupils new to my class as keen as the old ones. They come in keen and eager, asking 'what are we doing today miss', with an air of excitement.
- More of them are going on with A level – from 7% last year (all girls), there are now 20% doing physics AS, and from the exit questionnaires after parents evening recently, that number again next year, so I am really pleased with the intervention
- Several commented that they 'hoped' that they would now know more about careers, and contexts, so there was some suggestion that final questionnaires had not yet been completed.
- I have learnt that teaching the maths first is essential – I am thinking more about what they need before starting to teach the subject. This has impacted on pupils' confidence, they can prove (with the maths) that they have done what you have been teaching them.
- Pupils know a lot more about what physicists do, in what areas physics research is done, what physics means, and they are enthusiastic about it, have shared it with each other. Before the project they hardly knew anything about this.
- Working collaboratively has made them feel less that it is hard
- Their confidence has increased because I have given them time to express their ideas – that way they feel that their ideas matter. They love discussion and I think developing opinions about physics topics is very important.
- Pupils started to really enjoy and look forward to physics; this was a big change. It also means a big change for me – confidence that I can do it.
- Pupils asked good quality questions about science, I have been very impressed with that from the increase in discussion time.
- Pupils do better in exams as well, but that wasn't my intention, I wanted to show them the cool stuff and engage them.
- Asking pupils about how well they felt it was going opened up more discussion and debate.
- It has been difficult to measure, but they have a sense that we are trying to make it more interesting
- Pupils are more aware of what physics is compared to Biology and Chemistry and are more open-minded about it as part of a future career.
- More open-minded about other careers than the usual medicine that parents often push them into when they are very academic
- More pupil enjoyment/engagement (several delegates)
- More pupil voice (several)

- Some seemed more interested in parts of physics they didn't seem interested in before.
- The equipment bought from the funding showed immediately that you could do more things that were more exciting.
- An increase in the 'buzz' about physics, more positive attitude and feel in the classroom
- More involvement in practical work for the girls, hoping for reflection in uptake at AS
- My girls said that "actually, physics is easier than chemistry"!
- All pupils can mention careers now, whereas before they didn't know anything about it.
- Just focusing on the group makes them more engaged
- It has improved their confidence and enjoyment and therefore also behaviour management, lessons are easier to get through, and to make the most of the lesson is easier.
- Pupils are more reflective about their learning now. They know better how to improve.
- More enthusiasm and positive attitudes
- A better sense of what physics is about and about real life
- Filming increased pupil interest greatly because it was more modern, that's what they want to see – learning about physics that way.
- Pupils now believe it as well – their results were very good, they believe they can do it, their confidence is up

The most mentioned effects on pupils are increased engagement, enthusiasm and more positive attitudes towards physics, a better knowledge of what physicists do and about physics careers, and improved confidence.

Major effects of action research interventions on teachers themselves

- The initial pupil questionnaire was an eye-opener for me, I wasn't aware of how they felt and that has changed me a lot – what they think is relevant and you want to act on it (this was said by several delegates)
- I realise more what potential my pupils have – giving them thinking time has helped them phrase answers without fear of being wrong
- I have found out much more about physics careers than I knew before, and can answer questions better on it.
- It has allowed me to try other things in the class which are not on the scheme of work, which I might not have done otherwise.
- I have given more reflection time to the girls.
- I use the whiteboards in a variety of ways and it means I now know they are all involved in the lesson, and they know they have to listen. I don't use them all the time as the extra effort to remind some about how to use them is sometimes too much, but I can see lots of other ways they could be used.
- I have a bit more variety in my teaching now
- I will keep linking the context with the four classes I am focusing on and will carry out a similar project with Year 8 going into Year 9 as a control group, to see if the relevance can be changed further down the school so that their attitudes change earlier on.
- I have learnt that teaching the maths first is essential – I am thinking more about what they need before starting to teach the subject. This has

impacted on pupils' confidence, they can prove (with the maths) that they have done what you have been teaching them.

- I have learnt to be careful about expectations – the online environment I had developed for my intervention did not work as well as I thought it would. They needed a lot more training in how to use it, they were not as technology-savvy as I thought they were.
- It has been a very rewarding process, but the data haven't showed it at all!
- It has helped me with confidence as a physicist, I often felt out of my depth. I dreaded teaching physics and I didn't capture their interest. I have now shown a different side to my teaching.
- I have seen things I wasn't aware of, it gives you a different repertoire, you can show so much more.
- I have got to know my pupils a lot better
- From talking to specialist physics teachers I now know more about how to adapt things to real life than before, which really helps.
- It hasn't affected my teaching that much, my intervention was in careers and it was more of a bolt-on thing. There is a strong time issue, exam pressures, and pupils also get worried if we try to do too much in classes.
- It reminded me not to talk <u>at</u> the pupils and keep it short if you are telling them something.
- I have learnt how valid the pupils' ideas are. We do ask the pupils a lot but we don't often act on it to be honest. I didn't use to ask the <u>whole</u> group as such that often.
- My knowledge and enthusiasm for teaching physics has improved
- I picked up little bits of advice from sessions – don't do equations first; start with applications; bring in more real life context
- I have learned that the context is absolutely crucial, you need to <u>hook</u> the lesson, and then the content follows.
- Girls in particular see themselves as much more successful learners. They have seen themselves on video talking about physics in an almost new identity, "I am a successful learner at science", and it has increased their confidence and their desire to do well in the subject
- I would now want to build career options into my teaching in the future.
- Showing physics in a different light has changed my teaching because you have to be creative and with resources as well. You just don't realise how much is out there (*You Tube* etc) and they enjoyed it
- "Trying alternative approaches without being told off increases your confidence"
- My careers intervention also increased my own awareness of careers as I have liaised with the careers office and Connexions.
- I find teaching much more enjoyable now, using the equipment that without funding I couldn't. Pupils were much more bored before.
- Positive feedback from questionnaires gives you confidence
- I reflect more now, as part of my planning
- It has improved their confidence and enjoyment and therefore also behaviour management, lessons are easier to get through, and to make the most of the lesson is easier.
- Extra ideas from other people to try in future lessons
- More awareness about whether I am making it relevant for them, this is in the back of my mind more
- More general awareness about what I am doing.

- One of the biggest impacts of the project was that I was interested in my pupils

Major effects of the action research projects on teachers are on the whole: more thinking about including the relevance of physics; building in the context; valuing pupils' opinions more; teachers felt more confidence and enjoyment in teaching physics.

Major effects of action research interventions on the department

- I have made concept maps which everyone likes and some are really keen to use them – I hope they'll also take them to other departments, I'd like other departments to ask us about them
- Others in the department are using my resources (several delegates)
- I have managed to get it across the school, everybody wants it
- We share in mini CPD sessions across departments. I am G&T coordinator and some things I have tried will be relevant for other departments.
- I had a meeting in which other schools were present and they were interested, although what worked for me in encouraging girls physics teachers from other schools were not so interested in, they felt that girls are just not interested in physics.
- I have fed back at department meetings
- I am aiming for all teachers to use it, but no wider school impact. The physics department is where there is the most scope for teacher change – if I can get all physics teachers on board and they will use it with younger groups, it will have a big impact.
- We have already spent the money from the course on new data logging kit, and I have demonstrated it to the rest of the department, so they have a real effect from the course.
- I have re-written the scheme of work (I am the only physics specialist) for KS4 for all the department to use, including resources and links and ideas to use.
- I have felt more able to tell other more experienced teachers about what I have been trying and how it works, because of the course, because I have a reason to tell them about it, which would have been more difficult if I had not been on the course.
- Everyone in the department has given a careers focused lesson, so we have all had some involvement
- I am now part of a STEM Awareness group as indirect result of my intervention – I talk to pupils in Year 8.
- No impact beyond my own teaching – the results don't show what I was hoping for.
- Others have tried things that had effect in my lessons, but I haven't reached my endpoint yet, I am still awaiting the results. I hope to bring it to KS4 and get the other sciences involved.
- Colleagues are finding it quite interesting
- Some version of my idea will be done next year in school
- Will continue with a younger year
- It's a small department and I am HoD so what I have learned from others and my action research I will put into the Scheme of Work (SOW) and that means others have to do it. This applies especially to GCSE for next year.
- Physics activities are now included in the STEM clubs which might help with uptake of physics.

- No impact yet on department, but they have seen what works
- Informal discussions and some colleagues have taken it further.
- Only in case of last-minute emergencies do I think they will use my ideas, otherwise I don't think they will change what they do.
- There has been a culture change in the department: "Let's give this a go". I am Head of Department and something has really moved. Investigating your own practice is setting an example for colleagues. There are more discussions about learning in the department now, we are watching each other and trying things out. It helps steer the ship in a different direction.
- Doing this project has given science more status in the school; the money we used for equipment has made SMT look at science again which for me has been most useful.
- I did a CPD activity with a group of teachers so that has increased their interest further
- With the new equipment there was no excuse not to use it so that helped to move things forward.
- It's a very keen group of teachers so I just need to show them
- My ideas are tried across the department and will be implemented in the SOW
- More collaboration with external people

It seems general impacts on the teachers' departments are that often resources made are being used by other teachers, people in the department are often very interested; the projects will be continued with other groups and also implemented by other teachers. Also, more sharing in the department is mentioned.

Effects on girls and the more able pupils (G&T)

- Girls seem far more willing to participate in oral work; it is an able group so they would do well anyway, although they seem more engaged
- More involvement in practical work for the girls, hoping for reflection in uptake at AS
- Girls in particular see themselves as much more successful learners. They have seen themselves on video talking about physics in an almost new identity, "I am a successful learner at science", and it has increased their confidence and their desire to do well in the subject
- Letting pupils film themselves has given girls more of a forum, because boys normally do the talking
- There are different careers many now have had a chance to think about and girls might consider some of these which they were interested in, especially the more able girls who might not have thought about this 2 years ago.
- Able pupils were surprised by their results. They had not felt confident at GCSE (even though A* pupils) but now felt they understood it. This boosted their confidence so they are now more likely to choose it.
- Learning that limiting your intro and giving a good time for discussion should work for girls and not be detrimental for boys, which alters your lesson structure.
- Discussion got the girls a lot more involved
- Girls were more confident (from the data) but unclear whether uptake would increase

- Girls appeared more comfortable to discuss things in front of peers (with the others continuing their work) than boys (who wanted to do everything together and seemed reluctant to open up on their own)
- Girls didn't know before where physics could take them – now they know more, but it hasn't made an impact on their choices.
- Girls now see it as much more gender neutral now that they have seen what you can do with it as a career
- G&T can easily be forgotten, I gave them more of a teacher role in the groupings so they gained more extended knowledge and skills. They took the topic beyond the basics, then applied it and then explained it to lower ability pupils so it benefited them more.
- It seems to have a positive impact on girls' expectations.
- Lower ability and girls were now just as keen to get involved as boys, whereas before the girls couldn't be bothered to get involved with practicals. This was without more fancy equipment.
- G&T are normally a lot more boys [in physics?]; the girls are a lot quieter about being gifted and talented. I split them apart and you could see it a lot clearer, that the girls get overshadowed by the boys – they ask questions when the boys are not around. I know much better now who is gifted and talented which is quite interesting.
- 4/10 of the girls now take AL physics, although it is not certain that this is because of my project
- I was worried that I would switch off the boys by focusing on the girls, but the boys also like it. We now have an equal number of girls and boys in AL. Raising the profile of physics helps girls.
- Focusing on the girls gets them more engaged, and then the boys feel more challenged and work harder, so it works out for everyone!
- I dropped physics myself as a female so I am very aware and incorporate any ideas to help girls. It is about conscious awareness, if you do this, you have a slightly higher chance of retaining them.
- Girls like working in groups with one being responsible for feeding back. It has made them more confident in feeding back and explaining their thinking, which is a really important skill to learn. Earlier they were just wallflowers.
- Filming has given girls more of a forum to talk, because boys normally do the talking
- Different careers many have thought about which some the girls might consider, especially the more able girls. 2 are now interested who might not have thought about it 2 years ago.
- Able girls were surprised at their results, previously they did not feel they understood it and it has boosted their confidence so they are now more likely to choose it.

Many positive effects on especially girls are mentioned.

Previous concerns about teaching physics addressed by the course? Any remaining concerns?

- Physics knowledge – I now feel that my understanding and teaching is much better. My physics has improved
- I am hopeful that some of the things I did will have made an impact on negative views amongst the pupils about the subject (it's hard, it's not for me, I can't do it)

- I remain concerned about how physics is taught across the school.
- Still concerned about pupils lack in mathematical ability, English ability
- I am worried now that they are so much more engaged in KS3, that KS4 is going to be a big disappointment – it is desperate, it doesn't motivate us as teachers so how can it motivate the pupils? This is a growing concern for me
- Petrified about the lack of subject knowledge in physics teachers! Pupils are given the wrong information. Especially long term physics staff.
- The fixation on results, this is killing pupils' education
- The maths and science curriculum don't add up
- The maths curriculum is empty, all they ever do is triangles. The pupils can't even do basic algebra. We need to teach them maths, which is frustrating
- Some topics are difficult for some pupils, i.e. nuclear physics.
- Because of doing this with so much success by making the changes I did, I am now concerned that I have to change everything! It has worked so well! They have seen the other side now and it is not nice to go back to the old things. I don't want to hear: "well this is not how you did it before!" Do I have to rewrite everything now?
- We don't have any concerns
- Department without equipment, this has been partly addressed
- Just the fact that the course was not about being more able to teach physics – this has still not been addressed, but I have learnt other useful things

A some remaining concerns are mentioned by teachers, in various areas.

Changes to Schemes of Work

- I think we have all made changes in certain ways to the schemes of work, the way we think about teaching physics. P4, 5, 6, 7 are very challenging so they will be difficult to make exciting.
- This is now a priority in the department – easier accessible practicals that everybody will do
- I have put in lots of different activities into the schemes of work and made lots of different resources, so that is good
- The Scheme of Work is being rewritten now to include filming as a peer assessment strategy for groups of pupils

Discussion/reflection time changes

- I have increased discussion – with practicals for example, I stand back for 10 minutes to see what happens and I was very impressed by the discussions taking place. The pupils are so responsive I don't have to control the class as much.
- The pupils are more focussed on discussing because they are interested.
- They start discussion out of themselves now, as a habit, which is very positive. It is a confidence issue for them, and happens also because I feel more confident.
- I have increased both slightly, but there are time constraints. It does have a positive effect and I would like to do more of it.
- I let pupils do presentations these sparked a lot of debate
- My intervention was largely discussion based
- They appreciated having their thoughts listened to, enjoyed being part of this.

- Definitely more discussion time, but maybe less thinking time?
- Being part of action research helped/allowed them to reflect – why are we doing this?
- It wasn't really the focus but there was a lot more discussion.
- I have not made more use of it but the quality has improved (many teachers in the group confirm this)
- There is definitely more thinking, after the practicals, in addition to plenaries
- I increased it and pupils said they felt happier having that time
- All in the group have changed it
- Looking at meta-cognition in the school as well which feeds into that
- Girls' reflection on learning with help of filming – they are learning in a different way
- I am more likely to discuss a context at the start of the lesson, and to ask the children what they think about careers so they discuss this.
- The girls have more time for reflection
- The intervention has really generated discussion
- Jobs related to topics, what they can go into if they work in those areas
- My lessons are now heavily based on discussion.

Many teachers indicate that they have increased discussion, or that it has become a more natural part of their physics lesson. Thinking time is sometimes increased.

Usefulness of Action Research for improvement of teaching and learning

- It made me reflect on my practice – I tend to identify weaknesses
- The feedback from pupils really helped me to improve.
- It is very useful – it made me focus back down on one class which really helped.
- It focuses on your practice as a teacher – how you do things.
- It doesn't matter if you fail, you learn from everything, you're more willing to take risks
- 80% of the pupils agreed that physics has not much to do with everyday life which made me realise that it is my responsibility to show them
- Very useful – the pupils have got more out of it and are more engaged. Even if no more opt for post-16 physics, it is good. I will do more in the future. I knew quite a bit about it already but have learned a lot more. About planning – you need more time, how and when you are going to collect the data. I could have been more organised and effective about that with hindsight and could have better results therefore. The later round was much better than the first round of action research.
- Pupils really pick up on the fact that you are bothered, looking for clips and making resources. They then also become bothered!
- Incredibly useful – I felt ownership about what we were doing, and then you get into it more than when it is not your idea.
- Very useful because it makes you make a change, be critical about it, reflect on it and continue to improve on the change you have made.
- It is useful to continue your improvement as an individual teacher. It is useful to discuss other people's action research as well, but mostly for you as an individual.

- Surely every teacher constantly uses action research! Just not in a formal process which is called this. But this has more formally made me implement something I had wanted to do for a long time and it has been very useful.
- We do it anyway. We have to evaluate our lessons, we do it naturally, unconsciously, but in this way it makes you more aware of why you are doing it. It is being a reflective practitioner, relating good practice to theory.
- It makes you consider pupils' views more rather than your own.
- The course has reminded me that you can go back to it and look at it again if something doesn't work exactly as you hoped for. Having a go once at something is not necessarily the end of it. It is not a wrong thing to go back and change it. That way it is nice to actually end up with something useful.
- It allowed me to focus on a particular task and explore other issues as well and share with other teachers.
- We all reflect, plan and adapt, but the project has really taught me to think about collecting evidence about any impact rather than only going by what I feel. It is better, but why is it better? What is the evidence for that?
- Very useful experience in the short term, I will be repeating it. It is good looking back over the 18 months and seeing the effect.
- I think it is ongoing but lots of us have seen some benefit already in the short term
- Because it is evidence based it gives you something concrete that you can use to gauge colleagues' enthusiasm!
- It works especially well in the science department because we are data focused already – gives us a headstart.
- There are a lot of crap ideas in schools (SMT) that don't make a difference. This does make a difference **and** it brings in money. It is concrete, hands-on, rather than some university idea from people without experience in the classroom. It is our school, our pupils and it works here, it brings real change.
- Very useful. The fact that you had to produce something for the course meant that you continued to get on with it, knowing you would have to do something at the next session.
- Several voices said 'very'
- The children get a lot out of it, being part of a study meant something to them.
- I knew I had to change something but instead of a 'whoosh' job I did it properly.
- It was massively useful – you don't get that enthusiasm unless you do it yourself, you can see that it works, and other teachers can see it
- Performance management has moved away from improving classes. That used to be action research, so it is really good to bring that back.

Very positive views are expressed on the usefulness of action research – although some teachers feel that they all do it anyway, as part of their reflective practice. However, there was felt to be more chance now to go back to something that didn't work, reflect on it and improve it, whereas before, teachers were often inclined to just move on and try something else if something didn't work with their pupils.

Post-16 take up of Physics

- Yes more, they enjoy it now
- The questionnaire showed that a majority now say "Yes!" when asked if they would like to take physics, whereas before the majority was negative

- More girls are now interested to take it rather than the boys
- Hopeful about increase, especially for the more able pupils who normally tend to choose other routes. They look engaged, from gauging their interest for A level it is looking positive.
- Difficult to say. The intention is good but not as good as I was hoping. Physics just doesn't fit with what they want to do, they are already on a path and physics is not part of it.
- Uptake was good already, but some pupils who weren't before are now considering taking it.
- Uptake was already increased because of participation in the Girls into Physics project.
- A few more will be more likely to consider it as a result of my project
- Not sure, there are so many factors involved in that. But they do know a bit more about how useful it is.
- More girls want to take it but I know from digging that it is not because of my project, so I need to find out why it has changed.
- In one group: Yes, definitely more post-16 uptake (3 people); possibly (2); Maybe (2 – economic circumstances also playing a role); No (2); Same number of definite's, but a few more maybe's!; Will know better in a year's time
- I already have evidence that they have.
- Some of the girls who weren't sure are now more likely to say maybe. It hasn't affected the ones who are already sure, either to continue or not to continue
- Higher uptake at triple science than before: 4 groups instead of 2!
- Increased uptake at AS
- They are more likely to consider it now they know the more exciting things they can do with it.

Not many teachers have hard evidence for an (intended) increase in post-16 take-up yet, but there is often a sense that it might increase, taking students' enthusiasm and comments as indications. It seems that especially girls have changed their minds positively, according to some teachers.

4.15 Course Tutor Interview findings

Course tutors were interviewed for half an hour on the phone (sometimes face to face) generally within days of the final CPD session of the course. The questions can be found in Appendix 8.3. The findings will be summarised first and an overview of comments made per question will follow this.

Generally it is felt that the course has been very useful for participants in terms of having the time out of school and having a long period of time to reflect on their practice and to implement something in their classes; in terms of discovering and considering things they had never known/considered before; and sharing their practice with teachers from other schools. The process of action research was perceived to be inspiring for delegates and course tutors feel that an impact has been felt in the classroom.

The course content is generally seen as appropriate, although there some tutors wondered if not more time should have been spent on action research, with case studies and examples, or even whether the focus should have been on action research only. Tensions were experienced by some course tutors between focusing on learning about action research in the course and offering teaching and learning CPD; some delegates expected and requested some of the latter (based also on expectations raised in the marketing materials). Some tutors also felt that teachers had needed more support with their action research. Course tutors who had not been able to do so (most) expressed the wish to have been able to visit delegates in their school settings as it was felt that in this way, much more personalised guidance could have been offered.

The time span of the course was felt to be too short because all but one SLC were not able to start until middle/late autumn 2009. Many course tutors also would have liked to have a follow up session with delegates around 6 months after the course, as many will continue with their projects as they did not have enough time to finish the whole cycle.

Communication via the portal has been an issue – all SLCs report that this was unsuccessful and that new strategies to encourage this in the future should be worked out. However, in almost all SLCs, a real community came into being amongst the course delegates and many kept in contact with each other between sessions; some even visited each other at their respective schools.

Course delegates are generally seen to have engaged with their action research interventions very well, although some course tutors reported a clear qualitative difference in the projects of those with previous knowledge/experience of action research and those for whom it was a first acquaintance with action research. Tutors feel that almost all delegates have seen the value of action research for improving classroom practice.

Communication between course tutors and programme leaders about the course before the start and throughout was also seen as an issue and something to improve the next time so that there will be more joint planning. It was felt that for the next running of the course, course leaders and course teachers should meet well in advance to develop joint thinking on how the run the course and the course content – although it is felt that a lot was learnt this time and mistakes will not be repeated during a second running of the course.

The action research element is seen as something that is so successful by course tutors that they feel it has a place in many courses – it could be a very strong marketing point for the SLC network that it is one of their specialisms. For next/other courses, accreditation towards a Masters qualification is important.

Delegates' projects did not deliver and surprising results for course tutors as the ain surprises about effective physics teaching had already been during the Girls into Physics Project (Daley et al., 2009). One tutor was surprised by the surprise sometimes shown by delegates about their findings. Projects that were highlighted by course tutors have been indicated in bold in the overview of reports in Appendix 8.2. Many course tutors mentioned that teachers' giving special attention to their group(s) already had a big impact (the 'Hawthorne' effect). A surprise for one tutor was the increase in physics uptake post-16 that could be established by teachers focusing their efforts on the group of pupils who consider 'maybe' choosing to study physics post-16.

There have been some dramatic increases in teacher confidence during the course, but generally it was felt that many teachers were already confident and enthusiastic (the majority of most groups of delegates were physics specialists).

Other general points made by course tutors are that it is very difficult to know what the effects are of teachers' action research projects, as course tutors have mostly not observed teachers' classes and therefore have to rely on what teachers have told them and presented during CPD sessions; also, very few hard figures on physics uptake were known at the end of the course, another 12 months are needed to see effect in this area.

It was felt by one course tutor that gender issues had not been tackled explicitly enough in the course and that many gender issues could still be found amongst delegates with regard to their views on boys and girls studying physics.

4.15.1 How useful do you generally feel the course seems to have been for participants?

- Generally very positive experiences (one SLC: mixed because of conflicting expectations of delegates – action research AND professional development in teaching strategies for physics which was difficult to cover both extensively; one teacher did not value action research at all)
- It is felt that participants have generally thoroughly enjoyed it and engaged with it
- It has really made delegates step back and reflect on their practice; they have found out a lot about what's going on in their classrooms and institutions
- For those not quite on top of the work, or those who did not really see the use of action research, it was still quite useful, they have learned from it, but could have taken more out of it
- Impact in the classroom: definitely, it is felt - equipment; teachers using (and becoming more confident to use) different/new Teaching & Learning approaches, being more creative; some have developed some very ingenious resources
- To address teachers on a personal level and over a long period of time has been very effective helped to pick up issues and to progress along the way, according to one SLC
- Much stronger relationships have been developed with delegates and their schools than during 1-day CPD courses
- Time out of school was very effective for delegates, plus the long period of time 12-15 months helped to give them time to go away and think about what they wanted to do, think carefully about what they were doing and time to implement it
- Sharing ideas and resources with other teachers, learning from each other, supporting each other have been invaluable aspects of the course
- It has changed delegates' attitudes to teaching physics, they have started thinking about things they never considered before and have found out things they had no idea of, from talking to pupils for example and surveys

- It was felt by one course tutor that there has been a paradigm shift in their thinking and in the way they teach physics
- A lot of delegates want to take it further and will continue with their interventions beyond the course
- Some teachers called it “the best CPD they had ever been on”
- Process of action research was generally very inspiring for them
- Overall it was felt to have been an excellent experience for all involved

4.15.2 What do you feel worked well/was successful in the course? (in terms of the set-up, the content of the sessions, the action research element for delegates; the timing of the sessions and the space in between)

- The content of the course generally is seen as appropriate
- Day 1: usually spent on discussing Girls into Physics findings, Action research and how it works, the different methods that can be used, and some thinking about ideas for own action research projects
- In some centres: start very small-scale action research project to get some idea
- Day 2:
- In many SLCs, teachers feeding back about initial experiences of action research in classroom
- In one SLC: a specialist lecturer in action research held a more detailed talk about action research, which came at the right time as delegates had just finished their first small-scale experiences
- One SLC introduced standard research techniques to delegates and had them interview each other on camera and then transcribe the recording to make them aware of time needed for this, so that they would plan their projects realistically; and looking at surveys and their usefulness
- In some SLCs, the 2nd CPD day was the spring board for starting with own projects, before that they had tried some things out and had done a lot of reading to prepare, which was seen as very useful
- In other SLCs delegates were encouraged to start planning their main topic straight away
- In one SLC, day 2 was felt to be least effective as it didn’t provide people with what they needed in terms of action research – as the course was marketed as also offering teaching strategies, time was expected to be spent on that by delegates and some were very keen on that
- Day 3:
- Mostly feeding back results and reflecting on learning
- One SLC lost quite a few people during the course, due to recruitment issues, illness, and teachers changing schools and not keeping in touch
- One course tutor felt the 3 days were quite rigid, as individual teachers each develop in their own way in between the sessions, need different things at different times
- A couple of SLCs visited teachers in schools in between sessions which was seen as very useful, and by all SLCs this was seen as highly desirable, but difficult/impossible at this time (and in the future) due to time and cost factors

- Most SLCs spent some time on Teaching and Learning strategies, practical applications during the sessions, some held back and would have liked more time for this
- There was a good balance between action research, reflection, practice (traditional CPD), and feedback/responses according to one SLC
- 3 days was generally seen as appropriate although many SLCs would have liked a follow-up 4th day, for example 6 months after the course as many delegates are continuing with their research and it would be good to see the outcomes, and the results in terms of pupil results and take-up of physics post-16

4.15.3 What worked less well and could be improved?

- It was felt that the course should have run over a full academic year as initially planned. Instead it ran over two which caused problems for participants with new groups after the summer etc.
- For many SLCs, the total time of the project was shortened from 18 to 15 months as they started later and because of the end date of the project; this was not known in advanced so the teachers' planning was affected by it
- The gaps between sessions were not always ideal – sometimes too short, sometimes too long
- Some SLCs feel they should have given more introduction to action research on the first day so that participants had more of an idea about it, felt more confident to start doing it, and were reassured about the need of scientific rigour required. Showing them case studies might have helped as well according to one SLC; this was done in a couple of other SLCs
- More joined up thinking across regions at an earlier stage was considered desirable, as some SLCs felt left without much information on what to do on the first day, although they did not think this was a big issue
- In one SLC it was felt that the delegates were not very rigorous in their approach to action research, but the course tutor was hesitant to influence teachers' action research process too much and questioned to what extent he should have interfered. There was no brief about how much to interfere with delegates' projects
- Some SLCs felt that with hindsight, delegates needed more help with action research, as they were not very confident about doing it and it was not always clear to them when they were doing action research that they were doing it
- Another 12 months for more action research cycles would have cemented the learning, according to one SLC
- Presentations took up a lot of time according to one SLC
- Keeping contact with delegates between sessions was sometimes an issue:
- Portal was hardly used, this is difficult with teachers and some SLCs would with hindsight have used some strategies to encourage the use of the portal
- In one group, the community aspect did not develop at all, teachers did their own projects in the classroom and did not share anything with others until they felt it was finished (they were talking about "the lonely life of the action researcher"); delegates did not value the sharing part of the course; this was in contrast with the other SLCs

- One SLC felt that the impact award became more important than the action research itself at some point during the course
- One SLC tutor felt that delegates should have chosen their intervention in an area which they were already doing, to become even better at it, rather than choosing something completely new
- One tutor felt that they whole programme should have been about action research, not also about teaching and learning strategies
- The start of the course was shaky, issues were stumbled into along the way, there was a reactive rather than proactive approach, and not enough communication within the SLC network. There were issues with boundaries and sharing information across the centres, opening up the portal to all, etc. There wasn't enough time to solve all the issues before the start of the project.

4.15.4 How do you feel delegates have engaged with their action research projects? What impact do you think the training has had on teaching and learning?

- Some delegates had previous knowledge and experience with action research (Masters courses) and they benefited very much from the course, took it further
- Most teachers for whom it was new benefited as well, but it was felt some of these delegates did not engage very well. One person did not see the value of action research and kept resisting it throughout the course
- Most delegates seemed to have engaged very well and got a lot out of it
- It has made many teachers think about the bigger picture, about much wider questions.

4.15.5 Have delegates learned about action research in the way/extent you were hoping they would?

- It was felt delegates have learned greatly from their projects, see the value of action research for improving classroom practice, and have found out things they would otherwise never have known. It has given them more questions than answers and a lot of things to follow up on.
- Delegates themselves have commented as such as well

4.15.6 Have you developed ideas for new courses/learning from this course?

- Many say it has infused other courses they are teaching, but they have not really developed ideas for new courses from this
- Accreditation is important
- A follow up for this course, with Masters credits, refining the learning of this course is seen by some as very desirable, breaking down the barriers between University and school
- Supporting action research as a mode of professional development is seen as a very strong part of what the network can do and many people have an interest in that. The range of work SLCs do develops the skills of the staff

and it is good for outsiders to see this. Action research can be a strong element in many courses offered by the SLC network.

4.15.7 Have you come across any particularly interesting or surprising results from delegates as to what they found works well in the classroom?

- There have been a couple of really interesting projects in each group, but outcomes were not really seen as surprising by course tutors
- Sometimes surprised by the surprise of the teachers with their results!
- Interesting projects mentioned:
- One on experiential learning, starting at with applications which are normally at the end; introducing pupils to physics where no mistakes can be made
- Cross-curricular learning through collaboration with Science, Literature, Art and Drama, which had dramatic effects on pupils and created a real 'buzz' in the school about physics, completely changes pupils' views about physics
- Intervention in which teacher developed colour-coded concept maps in astronomy which pupils were given at the beginning of a topic, with lots of links between many concepts related to the topic. Initially pupils were overwhelmed by these but at the end it really helped them to link topics together
- Some targeted the middle group of pupils who could maybe change their minds about choosing physics, or who needed the subject without realising it, and got a big change (25%+) in pupils taking physics, which is a relatively easy, but massive change
- Hawthorne effect: big changes just by giving attention to the pupils!
- Sometimes big changes for teachers who had been teaching physics for a long time and had become stuck in their ways
- Good teaching and learning was very much being reinforced
- One tutor commented that many teachers had not chosen to focus on teaching and learning approaches, but rather on interventions outside of the classroom, raising the profile of physics; this tutor felt that interventions focusing on pupils working together for example are key to improving teaching and learning and that this would have had a greater outcome than raising the profile of physics.

4.15.8 Have you noticed any changes in delegates' approaches/attitudes to teaching physics, for example in their confidence/enthusiasm levels in teaching physics? – this could be from their participation in the CPD sessions or from lesson observations for example.

- Some were already very confident, especially when physics specialists
- Teachers who come to this course are already very enthusiastic, they are different from other physics teachers, there is something special about them, said one course tutor
- Some teachers came with very low confidence and have massively increased it, very dramatic changes seen there

4.15.9 Are there any aspects of the course that you feel received too much or too little attention, either in the CPD sessions or in delegates' action research and their reported learning?

- Action research theory and practice, case studies, examples

4.15.10 Other points:

- Impact can generally only be gauged from delegates at this instance – results are often unclear yet and most SLCs could not observe classes to witness the changes
- Not in all SLCs did delegates start with their action research after CPD day 1, which is important for the pupil questionnaires
- The reporting tool is felt by some to not reflect the richness of the intervention and the learning of the delegates as presented by them during the sessions.
- "Hawthorne effect": many teachers found that the mere attention given to the pupils already had a big effect on their classes (and relationships with pupils – which then affected behaviour management for example) and some were worried about the causes of their results. One course tutor indicated to have reassured delegates about this as this in itself is a useful and positive finding
- Addressing gender issues in the course: there has been communication about that amongst course tutors during the course of the programme
- Definite gender issues were observed in delegates – stereotyped views about boys and girls for example
- Gender issues are present for girls in physics and they need to be addressed; many teachers on the course came from all-girls schools
- Gender issues were not tackled explicitly enough in this course, this should have been coordinated early on
- The network needs to get together at the outset the next time the programme is run – course representatives as well as the people who will teach it

4.16 Specific outcomes for girls and able students

One of the course tutors commented that she felt that gender issues had not been an explicit enough focus in the programme, and that many biases could still be observed among the teachers with regard to gender specific behaviour and learning in physics. During the teacher focus group meetings, delegates were specifically asked about any particular outcomes they had seen of their interventions in girls and able students. The comments made related: i) to self-perceptions among girls as learners in physics before the intervention, and how these seem to have altered during the intervention (e.g. seeing themselves as proper science learners due to a peer-assessment task using video-recording); ii) how girls had become more involved in practical work and more engaged in discussion (away from the boys); iii) how girls began to consider some of the physics-related careers, and therefore saw physics as more gender-neutral; iv) how girls became more confident (for example when they were assigned roles in group work with other girls, and reporting back to the class); and v) how 'gifted and talented' attributes among the girls became more visible when they were split apart from the boys. Able students were reported by one teacher to be surprised by their result as they had not thought about themselves as good physics students before.

5 Teachers' action research interventions

This section outlines the participating teachers' action research interventions. More detail is shown in Appendix 1.
Of the 6 (*Girls into Physics)* research strands suggested by the course tutors, most projects were in the strands of *Careers & Guidance* and *Teaching & Learning*. Nine were in combined strands but again these were then often combined between these same two strands, or *Careers* combined with *Progression* for example.

Teachers' action research projects in the area of *Careers and Guidance* often consisted of the following activities:

- Getting outside speakers in (university professors, former students, both with high-profile, high-income jobs); for students as well as at options info evenings for parents
- Setting up physics clubs
- Letting students research careers and/or do presentations about what physicists do
- Posters/displays up in corridor/classrooms and regular updating of these

(These interventions did not always include activities within the classroom)

Interventions in the area of Teaching and Learning covered the following main areas:

- Questioning techniques
- Collaborative work / experimenting with single-gender/mixed-gender groups; groups according to level (single or mixed)
- Bringing in the context and applications at the beginning of a topic, rather than wrapping up with them at the end of a topic (seen as especially successful)
- Generally bringing in more real-life context into the lesson, for example small anecdotes
- More practical work
- Doing the maths first so that students can show they can do the calculations
- Working with concept maps
- Using Video peer assessment strategies
- Using more visual materials; use of more/new/creative/different materials (i.e. *You Tube* / using new equipment in practicals, funded by IMPACT award
- Bringing in more cutting edge/wow! physics and addressing "the big questions"
- Including more discussion
- Reducing textbook work
- Going outside the classroom more
- Bringing in cross-curricular activities/lesson plans

There was a wide variety of strategies used in teacher interventions and looking at the reports, it seems that teachers often tried to answer several big questions with their small and focused action research projects, which clearly could not all be answered within the scope of the projects.

To find out about issues experienced by students in physics classes, and to gauge the success of their interventions, often the evaluators' questionnaire was used and teachers regularly commented on how eye-opening the student comments had been, also when teachers had interviewed their students or held focus group meetings with them.

One course tutor commented that the reports did not do justice to the richness of the projects and the findings, and the learning of the teachers and students. She felt the reporting template was somewhat limited in providing the opportunity for teachers to describe their projects. As evaluators we observed that the reports did not seem very extensive; only small boxes were provided to describe projects and answer questions about them, i.e. research methods, impact, sustainability, next steps etc.

6 Limitations and issues encountered during the evaluation

- Teachers may not have given pupils the questionnaires at the point of measurement intended by the evaluators (i.e. pupils may have already started with the intervention)
- In some schools, the pupil baseline questionnaire/focus group meetings were carried out before the participating teacher had taught them, so the information gained applied to physics lessons of another teacher
- Some teachers reported pupil 'questionnaire fatigue'
- Some teachers did two complete rounds of action research, some had only really started in the second half of the course, but still sent baseline and interim questionnaires
- Teacher dropout (30+ lost over the course of the project – unable to contact for follow-up as most of the reasons were illness or a change of school without new address)
- Some SLCs finished the programme very late, so the evaluators received data later than planned
- Course tutors were often present at teacher focus group meetings, therefore teachers might have been less willing to be frank about their views on the course
- Pupil focus group meetings did not always consist of the same groups; also there were fewer groups for the second round
- Sometimes it seemed in the pupil focus groups that the teachers had already long finished their interventions and the pupils couldn't really think what might have changed
- In the case of career interventions, these were often 'bolted on' outside of classes so pupils might not have found changes in their classes
- Spurious factors! Generally, the success of the course as measured by all the research instruments used in this project, applies to one CPD course offered in slightly different ways in 9 SLC regions. However, all the action research projects carried out by course delegates were unique projects, with their own topic and methodology, carried out in different contexts, by different teachers, and with different groups of pupils. The more generalised measurement of the success of the course/interventions as a

whole is therefore subject to many factors and we cannot strictly refer to the evaluation of 'one intervention'.

- The impact award available for the school departments of the participating teachers might have caused the selection of a particular group of teachers/schools/pupils.
- There were several comments in the teacher interviews about the timing of the course. The teachers did of course have to put their intervention into place to suit their circumstances, but the timing of the course was unfortunately not what was originally planned – this was to run over two years with two action research cycles. In hindsight, this was never going to work as teachers and pupils move classes, so intervening with the same pupils over two academic years was never going to happen. The suggestions from the teachers were that the programme should have started in the summer term with the first CPD session introducing them to action research, etc. and allowing them to trial ideas before starting the programme at the start of a new academic year. The second CPD session could have been at the end of the Autumn term, setting them up for main intervention in January, running through as far as they liked to the third CPD session in the summer. Then the whole programme would have had continuity of teachers and pupils. (The *Girls into Physics* recommendations echo this approach too).
- There was some variability in the delivery across the SLCs, so that projects did not necessarily fit the GiP recommendations. Timing of CPD events was different and collection and quality of reports at the end of the programme was also variable.

7 References

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8 Appendices

Appendix 1 Overview of teacher action research interventions and outcomes

(NB Noteworthy projects due to their high impact, interest or surprising nature according to the course tutors, the senior managers or the evaluators, are indicated in bold)

Learning & Teaching Interventions with major impact

School Context	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
11-18 mixed gender, serving rural communities, 1278 pupils, 6% SEN statemented; a lower proportion than nationally eligible for free school meals. Less than one percent from minority ethnic backgrounds.	How can I increase pupils' confidence in the subject so that…. Girls are more involved in lessons More girls and boys take Physics at AS & A2 How can I help develop pupils' problem solving skills so that….. We can boost grades at KS4/5 RETAIN more pupils at AS & A2	modelled how to solve problems with modified answer sheets; devised a help sheet for pupils to have in their books as copy on the wall.	Increased grades for some groups; Confidence levels increased in another group; Intervention worked best for low ability set	Not in all groups increased grades	Change to teaching practice, but probably no impact on Y12 pupils for next academic year, but will focus on AS group when continuing.	Develop this further for higher sets
Mixed gender, 11-16, 1203 pupils, Specialist sports; 2/3 pupils from Indian backgrounds. Over 26 languages spoken. 50% EAL %FSM and %SEN/disabilities above average.	How can non-specialist physics teachers be supported when teaching the principles of energy transfers? What knowledge and understanding is needed to teach the difference between energy transfers and energy transformations? What processes take place in energy transfer devices?	I delivered an INSET session on energy transfers and energy transformations to teachers in the science department in my school. To prepare for the INSET I consulted physics textbooks to research how clearly authors distinguished between transfers and transformations. The INSET involved a practical activity and series of worksheets from basic to complex problems associated with energy transfers.	clear improvement in understanding of energy transfers and energy transformations following the INSET intervention, and every teacher participating increased his/her knowledge of the topic. Teachers also expressed a willingness to share ideas and resources to improve teaching and learning in the classroom.		The understanding acquired through the INSET will stay with the teachers throughout their career, particularly if they are actively teaching the topic. The retained knowledge in energy transfers and transformations will result in better teaching and learning in the classroom.	I would like the science department to have a teaching and learning slot during meetings so the focus is not wholly on administrative matters.
Mixed gender, 11-18, 1044 pupils, science specialist; rural comprehensive, most pupils White British, few minority ethnic backgrounds or EAL. %FSM and SEN below that in other schools.	Do pupils lack confidence in the Maths aspects of Physics? If so, how can it be improved?	Liaison with the Maths department on which topics are taught and when. Analysis of science curriculum to find the most common maths topics utilised in science. Use of Maths department expertise to deliver lessons on these topics within Science lessons. Positive feedback to pupils on their performance in these topics.	Little difference in results; tiny increase Small change in attitude and confidence in physics and chemistry; Noticable increase in correlation between perceived ability and actual ability in Maths and Science	Negative attitude change in Maths and Biology Pupils confirming maths content of science can be off-putting because of difficulty or lack of interest	I am hoping to extend the project by introducing Maths-for-Science lessons to other classes and other teachers. If this comes about, then I believe there will be a long-term effect in increasing pupils' confidence in the Maths in Science and so increasing the likelihood that they feel that they have the ability to take Science at a higher level.	I am hoping to introduce Maths for Science lesson to other year groups and other teachers.

School Context	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Mixed gender; 13-18; 544 pupils; specialist maths & computing; majority of pupils are of White British heritage although many other ethnic groups are represented. %EAL and %FSM below national average; %FSM %SEN/disabilities higher than average.	**Which questioning techniques stimulate/motivate/engage pupils for the longest period of time.**	**I tried to avoid hands up approach, unless it was a completely new topic. I tried out different questioning techniques to see which stimulate/motivate/engage pupils for the longest period of time. (thumbs up/down/across; random name generator; thinking time to pair/group; mini whiteboards; answer given, come up with question**	**Ongoing; the techniques I have learned from this I have shared with the department and will share with the rest of the school in CPD after school**	**I already knew how useful min-white boards could be but I learned more about the dangers of using them, outlined to me by my observers.**	**I feel that it has made a real difference to how comfortable pupils feel about answering and more importantly answering questions in the classroom. This has paid off at AS where I normally find pupils very reluctant to come out of their comfort zone to ask or answer questions. This year I have remarked on many occasions how good they are doing this.**	**Continue to use what I have learned to help others. No plans yet.**
Mixed gender, 11-18, 1790 pupils, Specialist Languages and Technology. Many pupils from advantaged homes; low levels of social disadvantage; %FSM low; virtually all pupils White British with English as their first language. % of SEN/disability well below average.	My original question was: "How does the relevance of what pupils are learning in Physics at KS4 affect their interest and keenness to continue to KS5?" After my initial research showed that this wasn't my pupils' primary concern, this changed to: "How does the teaching and learning of the mathematical aspect of physics affect pupils' interest and keenness to continue to KS5?"	I changed the way in which I taught the Year 11 "current electricity" topic to include less of an early emphasis on using numbers, symbols and equations, and use of colours	more male and female pupils said they found Physics easy. More also said they enjoyed the satisfaction of solving difficult problems. Responses to questions about thinking about voltages in colour were, in general, very positive The way that I taught the topic will be included in the new GCSE schemes of work for electric circuits. It will therefore change my own teaching as well as that of colleagues in my department.	female pupils were still less confident than males about their own understanding of the topic.	I will need to examine the numbers continuing to do AS physics at the start of the next academic year to properly assess the impact Approach will be sustained as all teachers will follow the new schemes of work. I am also keen to explore ways to teach Physics topics in a similar way, so the impact won't be limited to the teaching of just one topic..	I absolutely want to continue with my project. Girls said they were put off by the lack of interest and relevance to their lives. I now want to improve the relevance in my teaching and find out if this will affect pupils' attitudes.
Mixed gender, 11-18, 1658 pupils, sports specialist, rural comprehensive, most pupils White British heritage; low %EAL, %FSM below national average; %SEN above national average.	**Is there another way I can present Physics that enables greater access to potentially disaffected pupils? DO we always need to teach in a "top down" style?**	**Increased pupil modelling of concepts Showing the Physics "in action" *before* teaching the theory Allowing the concepts to become self evident from the examples seen by the pupils**	**renewed vigour for the subject. Pupils who previously were reluctant to get involved, now volunteer suggestions. The once habitual cries of "I don't understand" and "this is hard" have been replaced by "oh, right!" and "well, that's obvious". those with an aptitude for the subject who were already asking searching questions showing a deeper understanding.**	**not all pupils were entirely convinced by the new approach and interestingly, these would normally be described as "natural" physicists**	**This new approach has become a standard part of my teaching with many of my classes over many topics not just Physics based. I have had significant success with it in all years from 7 to 13.**	**I am aiming to extend my findings to apply them to Lower 6th Physics classes.**
Mixed gender, 11-18, 1608 pupils, specialist technology, diverse range of socio-economic and ethnic communities, largest minority ethnic groups Turkish, Greek, Black	**How effective is our use of language, questions and answers in helping pupils learn and understand physics? What are the effects of our use of language, questions and answers to teaching and learning physics in our lessons?**	**Questions were directed to the class orally and in writing on power point; 20 seconds thinking time allowed and pupils were picked randomly using lolly sticks and an electric random selector to answer. (no hands up-except to ask a question policy) Familiar vocabulary was used before scientific terms were defined and or**	**The no hands up policy has improved pupils attention, thinking time has improved the pupils phrasing of their answers and on the whole pupils have become more confident to answer questions and are no longer afraid of getting answers wrong. They are becoming aware that we learn from mistakes or getting things**		**The change is set to be long term. Our department has agreed to incorporate the interventions into the department policy to compliment other practices that are in place. Members of the department feel that pupils remain focussed and**	**We intend to incorporate careers and guidance in teaching physics-an application/extension of how science works in the world of physics.**

School Context	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Caribbean and Black African; %EAL well above national average, %SEN /disability above national average. %FSM well above national average.		used.	wrong. The use of non-technical terms in early stages has made pupils more comfortable with the technical and short hand forms when introduced. Pupils feel confident using symbols in formula triangles as a strategy for rearranging formulae as opposed to learning them. The use and understanding of formulae has improved significantly. Generally assessments results in our classes and the department are up. In addition pupils' perception of physics and other sciences is becoming more positive. there is notable enthusiasm and motivation in science lessons in light of the whole department adopting the interventions.		engaged.	
Gender: Boys; 11-16; 556 pupils Specialist status: Business and Enterprise Most pupils from areas with high levels of social and economic disadvantage; high numbers eligible for free school meals. Higher than average proportion of learning difficulties and/or disabilities. 80% from minority ethnic background; 75% EAL.	Focus on questioning task. How 'effective questioning tech helps make physics easy, relevant and more understandable	With my Yr 10 (higher ability) (triple group) I have changed teaching/learned more focus on 'questioning' (diff levels) tech	Attitudes changed, pupils are move positive to Physics Excellent GCSE results in module test More positive environment in class		I will continue with a different group	I might continue some interviews with other groups
Mixed gender, 11-16, 1273 pupils, specialist science; most pupils British heritage with a few from minority ethnic backgrounds; %SEN / disabilities average; resource base for hearing impaired pupils;	Questioning - Do pupils feel that the environment and their surroundings is important in whether they ask and answer questions? Do pupils enjoy using materials such as mini white boards in answering questions?	I tried a number of different ways to see how I could involve the pupils in their answering and asking questions. White boards were used in a number of lessons where all pupils had to try and answer open and closed questions. A stimulus was provided and all pupils had to think of a question that they then asked the class and then the class tried to answer.	All pupils felt that they could ask questions in their science lessons. All but one pupil felt that questioning was important in science and that they could ask questions in science 93% of the class enjoyed the use of whiteboards in the lesson. For me I have felt the white boards have had a positive impact in the	I have not managed to measure the impact this tool has had on their learning as I have yet to carry out an end of unit test where the white boards were a major factor in the modules lessons.	I will continue to integrate into my practice. It is something that I would like to expand and experiment further so that I could share findings with others in my department and possibly others in the school through CPD sessions	I will continue to look at ways to encourage pupils to study science and physics further. I will try other ways to get pupils to ask and answer questions. There are a number of other areas that have been identified

School Context	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Training School		**I also identified if pupils felt that they could and wanted to ask and answer questions in science**	**lessons. I have had engagement from more pupils in the class, been able to identify misconceptions, involve more in the lesson and turn the classroom into an environment that all are an active member of. Another activity that I have tried was providing a video stimulus to the class and they all had to come up with a question that they had following the video. They all got a chance to ask their question and the others in the class had to try and answer. All said that they enjoyed this activity as they got to have their say.**			**throughout this whole project and other things that I have tried during this part of the project that are ongoing such as the physics mural – which is developing at the moment and gets many pupils in the school stopping and looking at how physics impacts their lives. I wish to continue to look out for ways that I can encourage girls and boys to study physics and science further such involvement in the planet science PHYSCAST.**
Mixed gender, 11-18, 871 pupils, specialist science, serves a culturally diverse community within a challenging context. 10% are refugees or asylum seekers. 50%EAL; 2/3 SEN, mostly behavioural, emotional, or social difficulties.	How to improve teaching and learning of physics to Year 9 class How can I ensure all are focussed on learning all the time – and so I can check. Areas of my practice which need development – who is doing what in the class	Introduced the use of Mini White Boards to this Year 9 class (and subsequent classes).	Pupils verbally more confident – they understand more now; enjoy the lessons; were less scared of exams. (this could be due to a range of factors) Pupils are less able to coast below the radar in lessons if they are expected to show answers to questions all the time. Each pupil has a higher number of interactions with teachers when using MWB's than without. From mocks: (total class = 29) Pupils improved: 1 grade =14 2 levels = 6	Pupils stayed on same grade = 6 pupils Pupils dropping a level = 3 pupils	As long as MWB's continue to be used, the impact will continue. Needs continual monitoring of behaviour – if they draw / doodle the MWB's are removed from pupils. I need to convince other teachers what a useful tool this is.	Potentially through doing this, or just as a side line I have become quite adamant that starting GCSE in year 8 is ridiculous. As a department this has now changed and KS3 is remaining as a 2 year course.
Mixed gender, 14-19, 918 pupils, specialist language, Most pupils from White British back-grounds. Indian pupils largest subgroup; small minority EAL; %FSM and %SEN/disabilities well below average;	**How can we increase our pupil's engagement in Physics at AS level? How can we improve their attainment at AS level? How can we improve the percentage of pupils progressing to A2?**	**Improved course organisation (including use of topic summary sheets and past paper booklets). Improved engagement with outside agencies (trip to the Space Centre for the Careers Fest and for Master Classes). More practical work, integrating the practical skills component of the course into the scheme of work.**	**The summer 2010 AS results were much improved (from only 6% achieving their target or above in 2009 to 50% in 2010) and the stay on rate increased (from 25% in 2009 to 74% in 2010). We now have healthy numbers in both AS (20) and A2 (23). There is a more positive feel in Physics. For example, the pupils Year**	**The action research is sustainable and will have a long term impact as it has started a reflective process that will enable me to continually look at ways of improving our provision. Some of the changes are embedded in our practice; other will**	**Need to analyse exam data and look at progression from AS to A2 to see further impact**	**Integrate more about careers into our A level and also GCSE courses. Improve quality and content Physics displays to help raise the subject's profile. Overhaul our equipment and**

School Context	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Key Stage 4 provision made in partnership with local FE college		**Better range of teaching and learning strategies to promote engagement.**	**12 were definitely enthused by their trip to the Space Centre which opened their eyes to the exciting careers opportunities in Physics.** **In the classroom, there is a greater range of teaching and learning strategies employed to encourage more active and reflective learning. When pupils were asked to rate the course on average the pupils scored it 8.2/10, a shift upwards from the 7.5/10 rating from last year's Year 12!**	**need to be written into our schemes.**		**update some of our apparatus.** **Use the VLE.** **Physics Book Club.**
Girls' school; 11-16 years, 1093 pupils, CofE, Specialist Technology Status; Proportions of pupils from minority ethnic backgrounds and those new to learning English is below average, and the proportion with special educational needs and/or disabilities	Can lessons that focus on careers provide the stimulation for enjoyable learning and so engage the class in a more active way? [this report was classified as having 'major impact' by the researchers as the teacher had not given an indication if this. The intervention seems to have had quite an impact on pupil awareness of careers, even though no info is given on impact on pupil results and physics uptake.]	My intervention involved a change in focus of the lessons at KS3, from standard skills/knowledge based learning to a focus on possible careers stemming from the science learnt. The class chosen was a middle ability Year 9 class (all girls' school). The focus was on how the lesson objectives could broaden female pupil perceptions of physics careers. I wanted to introduce the pupils to a range of careers, some of which they had experience of through the media and others of which they had experience the product of those careers. A variety of activities around the themes of crime scene forensics, meteorology, stage lighting, oceanography, and archeology	Majority of pupils indicated they had enjoyed the lessons; they also indicated a greater awareness of careers using physics in ensuing discussions. They could indicate the reasons why every job listing included some kind of physics and were surprised at how broad the application of physics could be			
Girls' School, 11-18, 1531 pupils; Specialised B&E and Sport; inner-city school; most pupils from a wide variety of minority ethnic origins; proportion of pupils eligible for free school meals is very high. Nearly half of the pupils speak a language other than English as their first language.	**How can I improve engagement and attainment in core science physics?** **Which resources and equipment will facilitate the teaching of physics?**	**I attended the SASP physics programme to improve my own subject knowledge and teaching expertise in physics. This was to ensure I was confident and capable of delivering high standard engaging lessons to inspire my pupils. I set up the physics programme for the new specification for fast-track teaching. This included the schemes of work, powerpoint, interactive learning activities. I liaised very closely with a member of staff teaching the course to ensure we were delivering very similar lessons to our groups. I supported my**	**Liaising weekly with the colleague teaching the fast track programme with me has ensured both groups were receiving similar inputs from us. We were able to look very closely at the specification statements and match the teaching strategies to achieve them effectively. I have used the funding to purchase suitable teaching resources and other participants of the course have given me materials which have made a real difference to us. More practical activities have been built into lessons, more interactive activities**	**Look at the additional and separate physics SOW and adapt them according ly. Purchase more teaching resources with the rest of the funding from this programme. Collect exams data from the intervention sets and present them to senior management. Include a wider collection of physics disciplines in the careers section of the physics club. Organise a trip to an**	**This is a long lasting impact. The resources developed will be available for use for the foreseeable future. Any subject knowledge and teaching competencies that staff have developed will also be a long term gain.I intend to go on with the physics club certainly for the rest of this academic year and possibly also in the future.**	

School Context	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
		colleagues who required help with their subject knowledge to improve their competencies in teaching physics to their groups. My resources are available for all members of staff to use in their teaching. I started a physics club to explore career opportunities and expose a wide variety of applications of physics to our girls.	**and assessment have been incorporated and my girls have definitely said they were surprised how assessable these made the course to them. Resources have been purchased and adapted for different teaching groups and staff are better equipped to teach the programme. A whole department subject knowledge issue has been uncovered and discussed and hopefully CPD is being organised to address this. Through the physics club, some girls have met some very inspiring physicists. They were surprised how most of these did not fit their held stereotypes of physicists. They have been interested to discover the salaries some of them were earning. The year 11 pupils are not dismissing studying physics further forthright like they used to previously.**	**industrial physics lab for even more exposure for our girls.**		

Careers and Guidance Interventions with major impact

School Background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Mixed gender, 11-16, 913 pupils, specialist engineering; serving a rural area. Pupils from an above average socio-economic area, %SFM below average; %SEN average.	Do our pupils distinguish between physics and the other sciences? Can we increase uptake of physics at sixth form/college by improving pupil knowledge of physics careers?	1. Topic sort activity: pupils were asked to sort topics into physics, chemistry and biology. This gave us the opportunity to ascertain and improve their understanding of the differences between the three sciences. 2. Relevance of physics: pupils completed a quiz on significant physics developments. 3. Careers research: a discussion of the factors that are important for deciding on careers choices was followed by pupils researching then presenting information about various physics careers. This was supported by a display outside each classroom.	See presentation		Sustainable over a long period provided there is time given over in classes. Will look for small scale areas that will raise awareness of physics careers that easily incorporate into lessons e.g. future morph	Continue to discuss the differences between the three sciences at appropriate points in key stage 3 and key stage 4 e.g. start of year, start of new topic. Discuss career options at appropriate points e.g. end of a topic. Update display boards annually provided the resources are made available.
Mixed gender, 11-16, 1301 pupils; serves a	What is Physics and what careers need physics?	Presentations to the forms about the project and then asked them what they	Raising pupils' awareness at KS3 about Physics and getting pupils		With the second part of the project which is creating	Carry on with the fashion show and then

School Background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
relatively prosperous rural catchment area; Sports College, Languages and Vocational Education status; majority of pupils White British backgrounds and very few EAL. %SEN broadly average. Recently opened an on-site centre for pupils with Asperger's Syndrome.		thought Physics was via a questionnaire	thinking about careers in Physics and skills gained from its study. Pupils are more aware of the type of things that are taught in Physics.		display materials the changes should be longer lasting	create display material which can be displayed in the Physics department
Mixed gender, 11-16, 1002 pupils, specialist technology; majority of pupils white British with some from a wide range of other ethnic groups including an increasing number of Nepalese. %EAL above average. %FSM and %SEN below national average. There is an attached Hearing Impaired unit for seven pupils.	What is the current level of knowledge about career options in science amongst pupils and what are the career aspirations of individual pupils? What information do pupils look for when making decisions about post-16 subject choices and where do they go for this information? What is the current level of knowledge of physics careers of the teachers and do teachers currently include any careers information within lessons?	Based on the results from my survey of pupils and teachers, my proposed intervention was to provide more information on physics-related careers within lessons, and visual displays in the classroom and across the department. My aim was to relate individual lesson topics to specific careers in order to emphasis the relevance of physics as a subject.	Final impact has not been assessed. Within the target group there has been an observed interest in a minority of pupils with some of the careers highlighted The number of resources available to pupils on careers in physics has now significantly improved and can be incorporated into future lessons. There is a greater awareness of careers in physics across the whole science teaching department, and finally, I am better prepared to demonstrate the relevance of physics within potential careers.	The actual amount of time dedicated to the target group has been limited by curriculum timetable and needs additional time later in the year with that group for further action.	The resources prepared for this project will enable the intervention to be continued over a longer period and across a range of Year groups. The target group for the project will continue to be provided with careers information within lesson, and the work will be extended to other classes and Year groups	The next stage is to extend the intervention to a wider range of classes. I recognise that the project was limited to a small number of pupils. For greater effect many of the actions will be used for both higher and lower ability groups. Additionally, there are some practical-based activities that I would like to progress further as part of this intervention.
Girls' school; 11-16, 953 pupils; Specialist Language; pupils from a wide range of minority ethnic backgrounds; % EAL well above national average; %FSM high; %SEN/disabilities slightly above average. The school has a resource base for pupils with a hearing impairment.	**How much of an understanding do pupils have about what physics actually is and what sort of jobs do physicists do? What sort of things do physicists research?**	**Each week a different pupil presents to the rest of the class. The presentations can be about anything to do with physics – a recent development, space travel, a famous physicist, whether the science they have seen in TV shows is real. The pupil presents on their own. Pupils have a week to prepare their ideas – many have a couple of ideas and then check with me if it's an ok thing to present and get some guidance if they are struggling with ideas.**	**Pupils know much more about what physics is. They have presented on a wide range of areas. They have all chosen these topics, so clearly they have chosen things which interest them and which they think their peers will enjoy. They now have a much wider understanding of some 'big' physics questions – mainly because the presentations often spark lots of debate and questions. They also have an understanding of what types of areas physicists are researching and the very wide range**		**In my school there is a lot of pressure on academic pupils to go into medicine. But I would like to think that maybe a couple will realise that other science offer a viable profession.** **I am concerned that as KS4 is so content heavy that their interest in the more interesting parts of physics will wane.**	**I will carry on until July with presentations – a request from my pupils. In addition I have a visit from an engineer planned to talk to them about his job – as he works on a number of ESA projects. I would like to do some work with this class where we look at jobs in physics – that aren't**

School Background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
			of jobs that physics research involves. All pupils can now at least give few examples of physics or physics research, which they previously could not really. Many have expressed an interest in learning more. I didn't expect them to engage as much as they have done – the fact that pupils are asking to be next to do presentations because they have a great idea, is a really pleasant unexpected surprise. **I would like to hope that pupils who do this activity in Year 8 will enter KS4 with a much improved attitude towards physics.**			**necessarily closely related to research. I am considering asking them in groups to research jobs (and salaries) of people who have physics degrees.**

Combined Strands Interventions with major impact

School Background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Mixed gender, 11-16, 1043 pupils, specialist humanities; serving a relatively affluent rural area; very few pupils from ethnic minority groups or with EAL. %SEN low.	Does working in single sex groups within a mixed class impact in the participation and engagement of pupils?	**Learning and Teaching combined with Classroom Management**: Classroom – seating plan, rota of groups for practical experiments (single sex) Department – made aware of PAR and interested in the outcomes to use in their classes. Department – interested in any additional information/resources	My intervention has a positive impact on the classroom and the group as a whole. The dynamics of the group changed as the project progressed. Both the boys and the girls were a lot more focussed during lesson although the boys showed less progress than the girls. The girls were the first to be aware of the changes and were much more aware of the change in their work and progress than the boys.	I believe that for certain groups this intervention could be a great asset but in some groups could become detrimental especially to the boys. The results of my questionnaires and my interviews showed that the pupils felt the opposite sex could be distracting. The quiet girls were particularly aware of this and how it could make other girls distracting because of the constant giggling and silly behaviour. One pupil pointed out that girls are often needed to keep the boys on track because they can get distracted by anything if they wanted to.	I have continued teaching the majority of the yr 9 class into yr10. They have been split into 2 groups and more pupils have joined. Both of the groups I now teach are participating in Triple 21st Century Science. I have continued to use the single sex working groups in both of the groups but have a mixed seating plan.	I hope to build on what I have achieved so far and hope to encourage other members of the faculty to try some action research as I consider to have been an invaluable experience.
Mixed gender, 11-18, 1658 pupils, sports specialist, rural comprehensive, most pupils White British heritage; low %EAL, %FSM below national average; %SEN above national average.	**Will delivering a section of the GCSE Physics syllabus using creative, cross curricular teaching and learning techniques lead to benefits in motivation, interest and attainment for a Yr10 Physics group who are generally demotivated by physics.**	**Planned and delivered a completely different approach to introducing P7** **An integrated cross curricular approach to the subject encompassing Physics, English, Art, Photography, ICT and Drama.** **Pupils working in a very independent and creative way.** **Introduction of fieldwork/observation task.**	**From pupil interviews, journal entries and staff interviews it was obvious that the majority of the class enjoyed the "new" way of teaching and learning.** **The class as a whole were more engaged with and focussed on the work.** **A number of normally disruptive pupils really came into their own and worked in a very different way to their "normal" lessons.** **All pupils produced a final piece of work to be proud of.** **Pupils responding indicate by their answers to both questions in this section that they find physics MORE interesting after the intervention than before but the change is small.** **Pupils responding indicate a slight increase in the likelihood of them**	**Some pupils in the class indicated that they found it "hard to get their head round" the fact that they were using teaching and learning techniques from other subject areas within science.** **This was backed up by teacher interviews, where non science staff felt that just by delivering the project in a science classroom, (physically) pupils found it more difficult to access the skills they have developed in other subject areas.**	**I believe the work is sustainable as evidenced by other departmental staff running with the ideas.** **The school as a whole has a focus on creative, cross curricular teaching and learning and is working towards the building learning habits agenda.** **There is a will from teaching staff to continue with the work.** **There has been a longer term positive change in attitude toward physics from a number of pupils in the class, however some of the more disruptive and demotivated pupils have returned to their previous modes of work and behaviour.**	**Review academic impact of the project when GCSE results come out.** **Modify and Deliver project again with a current Yr10 class.** **Look @ delivery in non subject specific geographical areas where possible.** **Create a Project Resource Pack which could be used by other schools to help them deliver the model.**

School Background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
			studying physics post 16. All staff involved in the project felt it was an incredibly powerful way of working and from a professional point of view really enjoyed being able to work with colleagues in this creative, cross curricular way. The work has already been disseminated within the department and other teachers have taken onboard the ideas and developed "spin off" pieces of work.			
Mixed gender, 11-18, 1135 pupils, specialist Arts; Almost all pupils of White British origin; a few from a range of minority ethnic backgrounds %FSM average; %SEN a little above average. The main difficulties are social, emotional and behavioural or moderate learning difficulties.	**Does practical work which has equipment which can move pupils from experiments of a qualitative nature to a quantitative nature secure more enjoyment and better results.**	**I bought equipment such as energy meters and associated input and output devices (transducers) which enabled readings for Power, Current, Voltage and time to be taken quickly and easily. This enabled pupils even of a low ability to set up the experiments themselves and get reliable concrete data to create tables and draw graphs. Then they could spend more time conducting analyses and making concrete conclusions about energy flow.**	**Pupils have stated how much they enjoy using the new equipment. Lessons have changed as demos have become whole class practical. Non-specialists have become more confident and daring in their work as the equipment is so simple and has full instructions. Also the schemes of work are changing and staff will have to use the new equipment as the BTEC scheme has to be followed unlike the old schemes where you can pick and choose. We have been able to do different ISA exams for KS4 which is really good as the test was better for our pupils to take. In KS3 pupil have used the new class sets at a lower level that KS4 but at a higher level than previous years which is obviously very good progression. It was unexpected but when I got involve d in this project I used the idea and won the Rolls Royce Science Prize of £1000 and so invested more money in the project – very unexpected!**		**This project raised the profile of Science with the governing body of the school and HT and thus they saw the project was creating success so invested another £1500 of money into buying a whole set of radioactive sources, protactinium generator, spark counter. So the success is breeding more success. Also pupils should pick more Science at A-Level which will bring more investment into the department.**	**I am just going to carry on as I am, buying more equipment and trying to create lots of whole class practical KS3->5 as this is the key to good learning and lessons.**
Mixed gender, 11-14, 503 pupils, specialist	**Can making short films to document a physics topic**	**I attended an evening course on the use of film making as a classroom**	**Data collected showed that all but one pupil scored their understanding**		**Clearly this is a very successful intervention and therefore it**	**To write the use of film making into the**

School Background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
sports, great majority of pupils from White British backgrounds; %FSM below average; %SEN average.	improve pupils' learning outcomes? Is film making with groups of pupils within the whole class setting an easily managed and efficient use of curriculum time? Do pupils enjoy this classroom activity and does it enhance their self-esteem?	activity by Ignition in Nottingham. Here I found out what equipment I should purchase and how this equipment would allow groups of pupils to work along side each other making films in the one lab. Following this I contracted a trainer to carry out more training with my science dept using the equipment we had purchased. I then worked with a mixed ability year 8 group using three lessons in which the class worked as groups of pupils to successfully produce 2-3 minute films on the topic of light and colour.	and learning in the physics concepts more highly after the film making activity. Less able pupils showed a higher increase numerically in how they ranked their level of confidence about their learning after the intervention. The pupils were very keen to work together in this project and it was particularly noticeable that unlike usual science practical activities girls played a very equal or at times dominant role. This was particularly noticeable with regard to middle to less able ability. Pupils were very involved in this activity, self-motivated and quick to make links with the previous lesson. They were keen to research and ask questions and driven, I believe, by the outcome of seeing the end product…. their group's film. Changes in department and classroom; The dept has six cameras, tripods and microphones that can easily be used by pupils The science technician is very skilled in supporting this work in the classroom and keen to get further involved. The success of the intervention is clear and therefore others are keen to incorporate the activity in their lessons		is important for the dept to look where it can be built into the programme of study. It is sustainable for as long as we can maintain the equipment and as long as we do not get huge numbers of pupils' parents who do not give their permission for their child to be filmed in class	programme of study. To try to obtain some funding that will release teachers to achieve this and the outcomes described earlier - progression of skills, identified pupil roles, metacognitive plenaries, links with other schools and outside agencies and professions.

Careers Interventions with some impact

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Mixed gender, 11-18, 908 pupils, specialist sports, serves an area with considerable levels of social deprivation, %SEN well above average. Very few pupils are from minority ethnic backgrounds or are at an early stage of learning English.	Can linking careers in science to science topics have an effect on learner's motivation?	Future Morph Clips were shown at the beginning of lessons and linked to lesson content – where possible	This has had a very positive impact on learners. They now link their learning to a possible science career. It has also broadened their knowledge base of science careers available and increased enthusiasm towards science in general. They now have a more realistic and positive view of a science career and an idea of its earning potential		I hope it can be sustained over a longer period – I will continue to show Future Morph and discuss careers to the groups I teach	I plan to continue integrating Future Morph into lessons
Girls' school, 11-18, 852 pupils, specialist arts; school draws its pupils from a very wide range of backgrounds including some areas of significant economic disadvantage. 20% FSM; 75% ethnic minorities; 50% EAL.	Does a better understanding of physics related careers lead to increased uptake of the subject at A-level.	I included physics careers information in lessons. This involved finding relevant physics careers that would use the skills or knowledge covered in the lesson.	My intervention has not made more of my pupils more interested in studying physics. Pupils responded well to the careers information in the lesson, and were able to explain how physics could be useful in the 'real world'. I will continue to use the resources developed. Hopefully this small change in the perception of physics may lead to more pupils taking physics in later years.	Through interviews with the group I found out that although they found the careers information useful and interesting, it did not influence their decision. The main reason the pupils are not choosing to study physics is that they find it too challenging, and the course studied (Edexcel Core Science) did not give a good impression of what physics was.	As a result of further discussions with pupils, I have found that they are far more likely to choose a subject based on whether they enjoy it or not rather than how useful it will be in later life. My group identified the Universe as the most interesting and enjoyable topic in physics, and liked the 'big questions' that the subject raises. As a result of these conversations, I put together a presentation that can be shown to prospective pupils to try and encourage a greater uptake. To see the presentation please visit the following website: http://prezi.com/bl382esagj9t/why-study-physics/	I plan on trying new methods to increase uptake at A-level. This has included looking into GCSE astronomy as pupils seem to enjoy learning about the universe in physics lessons.
Mixed gender, 11-16, 1097 pupils, specialist technology, most pupils of White British heritage and 0.9% do not speak English as their first language. %FSM and %SEN well below the national average.	Will the science in industry talks increase the number of pupils looking to carry on with physics at a-level? Will the intervention increase the pupils perception of how useful physics is in the wider world?	I started ensuring that every opportunity to highlight the relevance of topics to real life scenarios was taken. We started looking at how momentum calculations could show who would be the most difficult rugby player to stop and what would be the momentum of a car that would strike a child etc. I also invited local people whose careers could relate to physics into the class to speak about how physics is necessary in their jobs, this included architects talking about	The pupils been a lot more enthused in physics and are now seeing the subject as a lot more enjoyable (from verbal feedback, so far). An unexpected outcome was that the classes behaviour and in their other science lessons did also seem to have been more positive. The children also seem to be much more enthusiastic to carry out independent projects. The evidence for this is from verbal feedback from pupils and of teaching staff.	The evidence from the questionnaires is less clear, the pre intervention and post intervention questionnaires indicate that pupils seem to think that the biggest change is that the physics as a lot more inclusive for both sexes, there is also greater uptake in physics at A level, However the mid intervention questionnaire	Because of early positive feedback from this research I have now contacted Peter Tribe, who is our local Stem Ambassador Coordinator, about getting Stem Ambassadors in on a regular basis for all three sciences and have also been working closely with a Stem Intervention Group in school and have suggested that other STEM subjects do the same.	I am looking at increasing the numbers of talks and also starting these early in year 9, before pupils pick subjects for their GCSE's. Other STEM subjects have also indicated they will do the same.

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
		sustainable materials and web links with a pilot talking about energy transfers, momentum and conservation of energy.		showed much higher enthusiasm for A-level physics, so this has dropped off slightly during the latter stages of the research.		
Girls' school, 11-18, 415 pupils, specialist maths and computing; socio-economic status of the vast majority well above the national average.	Whether pupil research into Science careers would encourage more girls to consider Physics for A-level	Pupils were given a long list of different careers which are known to require a scientific base. In pairs they choose one to research further and websites such as physics.org and futuremorph.org were given as starting points for research which would be reported back to their peers in Science lessons as five minute presentations. These presentations would be electronic so that they could be referred to at a later date by all pupils. In addition a couple of presentations were arranged by STEM ambassadors to inform girls of their roles and emphasise the need for STEM A-level subjects. i.e. Physics in combination with other Scientific/Maths A-levels. Visit of University Professor John Burnham and former pupil who is a successful engineer.	There is an increased number of girls wishing positively to take A-level with a few more considering this: Would they wish to do physics to A-level: Now: Yes-15, No-33, maybe-3 Before: Yes-8, No-43 Teachers supervising the pupils making these presentations have been impressed with their clarity and depth imparting useful information to their peers.	However the impact of the careers research and feedback by pupils gave this response: Yes, makes me want to do physics more: 7 Yes, makes me want to do physics less: 4 No impact at all: 43.	I would like to pursue the large number of girls who responded that they had lost interest in physics through interview to find out the reasons for that.	
Mixed gender, 11-18, 1669 pupils, specialist maths and computing; %FSM a third of national figure so is the % of pupils from minority ethnic backgrounds. %EAL low. %SEN half the national figure. There are a small number of children in the school who are looked after by the local authority.	**To increase the number of pupils taking Physics at A Level. To raise the profile of Physics as a subject.**	**At the beginning of a lesson, I highlighted the job(s)/career(s) that would use the physics about which they would be learning today. The pupils were also set a homework to research a job/career, that they did not previously know about, that involves physics. The research was then shared with the rest of the class.**	**Comparisons pre-post questionnaire show that many more pupil indicate they have had careers talks, especially with the science teacher. I feel that the awareness of pupils has increased. They are starting to realise that Science is 'not just an isolated school subject', but something that is relevant to their future. I am definitely much more aware of my practice. I am including references to jobs/careers within all my science lessons.**		**With regard to the pupils, hopefully the change will last. However, I think this is related to how often the subject of jobs/careers is raised during lessons. I will continue to do so and I will be sharing my research with the Science department and encouraging my colleagues to mention careers also.**	**Through doing the Action Research I have become interested in STEM. I am investigating attending a SLC course to further my knowledge, and having a STEM Ambassador come into school to talk to my year 10 Triple Scientists about a Physics related subject. I have attended an in-house training session on using the Survey Software on the school system. The school is currently**

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
						using the ASE Wikid KS3 scheme of work and I am interested in seeing whether the 'context' led approach has an impact on the number of pupils opting to take Triple Science and whether this has a knock on effect on the number of A level Physics pupils. I hope to be able to monitor these outcomes in the future.
Mixed gender, 11-18, 2148 pupils, specialist Maths and Computing, Pupils from diverse socio-economic backgrounds, most from a white British background. %SEN below average.	How can teachers Improve awareness of science careers? Do pupils know what careers in science are and what qualifications they need to do that career? Does effective science careers advice have a beneficial effect on KS3 pupils taking science/physics after GCSE?	Use of the internet to increase awareness of Future Morphs website. Pupils were asked to use the Future Morph website to use the quiz to find out their skills and what science careers those skills would be useful in. Some posters were placed in the classrooms highlighting physics careers (IOP posters) and Chemistry careers (RSC posters). A notice board in the main corridor was completed which highlighted the Future Morph website and STEM ClubActivities.		The overall outcome from the pupils is not as positive as I was expecting. The pupils that already wanted to continue their science studies had already decided by Year 8. Data from the pre-intervention and post intervention for two of the questions are given below. It may need this intervention to be used in year 7 or at Primary school rather than Year 8 or above. One of the post - intervention questions on the survey had asked pupils what science careers advice they had learnt about but 8 pupils said they had not had any careers advice in science. They surely should have remembered the two lessons in the computer room looking at a website. They had not made the link which begs me to ask, What had I been teaching?	On a small scale it should be a continual hook in most of my lessons. It however needs to be shared with the department and school.	From reading around the subject and previous research I found some articles of interest. Monk's 2008 report,"The flight from physics education: searching for reasons by comparisons across the curriculum" has highlighted science is doing well against other subjects like music and languages. However the uptake of pupils studying science subjects beyond GCSE has declined over the past twenty years. IOP, STEM net and science teachers are doing some interventions to increase the numbers of pupils studying science subjects. However the Science Community Representing Education (SCORE) News report in 2008 highlighted that maths,

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
						physics and languages are the hardest A-levels to achieve A grades. This might be an article that could help increase awareness of the subjects in a positive light for higher education institutions but may put off pupils studying the more difficult subjects. A possible opportunity would be to ask HE and FE institutes what they think of this report and what emphasis they put on to Science A-level grades.
Mixed gender, 11-16, 1299 pupils, specialist maths and computing; Pupils from generally advantaged semi-rural areas. Almost all pupils of White British heritage. %FSM very low; %SEN b broadly average.	How can pupil perception of the relevance of Physics to their lives be improved?	Highlighted relevant careers linked to various Physics topics by use of specific research (see ppt presentation) Visited nuclear fusion centre in Culham Included specific STEM careers lessons into teaching	Conversations with pupils about their futures. Some using STEM links I gave them to use in their own time. One girl asked for copy of the STEM powerpoint I used in a lesson and the case studies. When looking at the evaluation sheet I gave them towards the end, a big majority feel that they now see why they are studying certain physics topics in school, as a result of the intervention strategies.	However there was no increase in the numbers planning to take A level physics at this stage.	Physics trip can now be planned for and incorporated each year. Inclusion of further STEM lessons in the future as the pupils valued these a lot.	Investigate more physics visits e.g. residential to Oxford to include Culham again and also possibly the Rutherford Lab. Get more STEM information and try to invite speakers in as several pupils said in their evaluation that this is what they want.
Mixed gender, 11-18; 1228 pupils; specialist Sports; Most pupils are of White British heritage; %SEN and %FSM below national average; %EAL well below.	Research which careers interest girls of approximately 16 years of age. What they understand and like/dislikes about Physics. From the research, develop a course of action to promote Physics to girls and enhance how Physics can be used in their career choice if possible.	Raise awareness of how studying Physics can be related to their career choices. This has been undertaken by contacting the local University admissions officer getting them to relate studying Physics to admissions on Law courses. Make available a set of videos showing how vets use sources of radiation. Learners visit the scanner at Peter Manchester Suite, Nottingham University.	Have shown the video's and taken a trip to a medical facility. 84% of pupils can now see how physics can be used in medicine.	still only 24% of the pupil's surveyed said they would consider studying A – Level Physics.	The classroom invention will remain in place and hopefully we can continue to run educational visits and develop further links with other professional/institutions.	I want to relate Physics to the study of Law at University and ultimately a position in the legal profession.
Mixed gender; 11-16; 778 pupils, specialist	How can I gain promote interest in Physics using	I displayed career posters around my classroom and on the science corridor.	The display boards have made some impact.	intervention is ongoing and I am waiting for the	Initially short term, however, can now be long term with the	Working with STEM rep and film companies

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
technology; %FSM above average. Large majority from minority ethnic backgrounds, mainly Pakistani; large % EAL. %SEN more than average The local authority's visual impairment resourced provision is housed at the school.	careers information. How can Physics be made modern and appealing for KS4 Pupils.	Showed future morph web site on the smart board when pupils enter room.		completion of this engineering video to self-evaluate this research.	promotional video involved. As this can be shown in school year after year to promote physics careers.	to make other films focusing on other areas of physics.
Mixed gender, 11-18, 2108 pupils, science specialist; serves a largely rural area. Large majority of pupils are White British and most are materially advantaged. %FSM low; %SEN around national average.	How can we encourage more **girls** to study A-level physics?	The focus classes were the 4 triple science classes in Year 11 (approx 100 pupils) and 6 triple science (approx 150 pupils) classes in Year 10 (2009-2010). The project began with using seating plans to group pupils in groups according to target grade following the December 2009 Year 11 mock exams. Through conversations with pupils it became apparent that the two key factors that influenced the subjects studied at A-level were enjoyment of the subject and career aspirations. The decision was made to focus upon making pupils aware of the range of science-related careers open to them and how studying A-level physics was linked to these careers. In July 2010, the teachers of all 6 Year 10 triples classes delivered a careers lesson planned and resourced in conjunction with the school's careers AST.	The "exit poll" from the 6th Form Open evening held in November 2010 suggests that the total number of pupils studying AS physics will remain constant at approximately 45 for September 2011 and the proportion of girls will also be approximately 20% for the second year running.		With continued careers guidance intervention in the Summer Term the 20% benchmark for girls studying A-level physics should be sustainable over the next few years. With the introduction of new GCSE specifications from September 2011 the timing and content of the lessons may need to be reviewed but the essence and purpose should remain the same.	The next steps of the project include: Retention of pupils from AS into A2 Use of Year 12 Physics subject captains in promotion of AS Physics to Year 10 and 11 pupils Guest speakers from physics-related careers Long term goal – improving attainment of C/D target grade pupils at AS/A2
Girls' grammar school, 11-18, 813 pupils, specialist technology; %FSM and %SEN well below that usually found nationally. The great majority of pupils are of White British origin.	Can a one hour dynamic and interactive presentation change how pupils perceive physics? Can such an experience make a significant difference to motivation and interest in a subject, and subsequently result in HE/FE study? Is this more powerful when delivered by a known staff member rather than an outsider?	The first step was to consider what sort of demonstrations would engage pupils and give the 'wow' factor. Consideration was also given to how the topics addressed in the demonstrations can be linked into exciting science and promoting higher education and careers. Energy Transfer as a whole theme fitted the requirements, and the unusual demonstrations settled on were the Reuben's Tube, *Jacobs ladder*, Thunder bottle, *Maglev Rocket Train*. Each of these elements have been (*will be*)	Following the work, the resources created may be used in one or more of three possible ways, depending on the outcome of the research: Teacher continues to make the presentation within the school (120 pupils per year affected) Teacher offers the presentation to other schools (many more affected) Other schools borrow the equipment, and with appropriate guidance, a suitable member of staff can deliver the presentation themselves as many times as appropriate in the school.		It is possible that this project could run for many years. Ideally it will develop and improve as further ideas and resources present themselves. It might well fit into the annual curriculum cycle for all KS4 pupils in the school, or may form part of a large presentation to whole year groups. There is no reason for the work invested to be exploited only once	

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
		tested in front of classes in terms of wow factor, and information input from presenter. The final product, including integrated ICT support (sound and visual created on Powerpoint) will be presented to the audience.				
Mixed gender, 11-18, 1032 pupils, specialist Arts; The percentage of pupils from minority-ethnic groups and %EAL higher than average %FSM above the national average. %SEN/diabilities slightly below average.	Are pupils aware of different careers they could access as a result of doing science?	Within my own classroom more emphasis especially at key stage 3 but also in key stage 4 is placed on career in science. What they would need to learn to do a certain job, why would different careers need science as part of their job, more unusual science jobs linking in arts and media. Starting to complete a science jobs scrapbook. Within some classes peoples have had STEM ambassadors to talk to them and had a STEM careers event. Department is starting to do the same due to APP. School- STEM resources are becoming more widely used in technology department as well as science.	Pupils involved in the project are more switched on to careers and attitudes have improved as a result. Within a few classes there has been the introduction of a science careers scrapbook which has lifted the focus of careers.	For some pupils this has been a negative impact also as it has made them think they definitely don't want to do science and therefore their attitude has decreased.	Short term- pupils attitudes have changed and more pupils are doing triple science this year compared to other years. Long term – it has started to become embedded into my teaching although others unsure.	Find out which is a successful way of teaching science careers in school.

Learning & Teaching Interventions with some impact

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Mixed gender, 16-99, FE college; large general further education and tertiary college with vocational skills centres; located in an area of considerable disadvantage; 75% of the college's 16 to 19-year-old full-time learners are in receipt of (EMAs).	The broad question was to consider why pupils were not progressing from AS to A2 physics, and also from A2 physics to the study of the subject at university. I wanted to see if I could encourage more pupils to enjoy the study of physics at A level by increasing participation and engagement with the subject outside of lessons. My more specific concern was that many of our pupils found difficulties with the extended writing or discursive questions, so I wanted to develop their writing abilities using a rather indirect manner.	The project ran from October 2009 to the pupils completing the academic year in June 2010 - when the pupils sat their AS examinations. During the year, pupils were encouraged to develop their own pages or contribute to the group wiki site. The research questions could then be answered by analysing the AS results to see if there were any improvements upon the previous year, by assessing the number of pupils who progress from AS to A2 physics, and whether any pupils then decide to further their study of the physics at university. The aspect of written communication could be evaluated by comparing written work that pupils had completed at the start of the course to that produced at the end of the project to show whether improvements in powers of written expression had been made. The project was successful for the aspects that are harder to quantify, such as building up a group identity, creating a learning environment where sharing with each other is just as important as being taught by a teacher, and creating a genuine 'buzz' for the subject! The only unexpected outcome was that it proved a particularly successful medium for a pupil with Asperger's Syndrome to communicate with other pupils. When this pupil started at the college, he could not speak to anyone and needed a full time carer to be with him at all times. He really enjoyed uploading material and sharing his passion for astronomy that other pupils readily warmed to him. This pupil has thrived personally, as well as academically, through being able to communicate in this way.	The achievement (pass) rate improved from 57% to 83% and the success rate improved from 54% to 75%. The number of pupils who progressed from AS to A2 increased (14), as well as the number of pupils who have now applied to UCAS to study physics or engineering at university. Whilst this latter number is only 6 pupils, this is an increase from the previous year when no pupils applied to study physics or engineering.	The retention rate did not improve for AS physics, but that was largely due to factors outside of my control	As the college is currently in transition from Blackboard to Moodle, we are unable to develop a similar project at this point in time. As soon as the transition phase is over, we can then consider starting the project again for the forthcoming year. Once set up on Moodle, we can operate the sites for future physics classes with a view to it becoming a normal part of the course.	I am still very interested in using the college VLE to encourage and motivate pupils, but many of my pupils have asked about podcasts for physics! This is an area that I would like to explore in the future and utlilize the pupils' fascination with their technological gadgets! I was very impressed with the work done by pupils this year and found that all of the pupils wanted to contribute in some way.

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Mixed gender, 11-18, 1396 pupils; specialist humanities; %FSM well-below the national average; number of pupils from minority ethnic backgrounds is a quarter of the national figure; %EAL low; %SEN just below the national figure. There are a small number of children in the school who are looked-after by the local authority.	How can learning conversations be used to improve pupil aspiration and achievement in Physics?	I initially planned to carry out individual learning conversations with member of my Y10 (now Y11) Triple Science Physics group. This started with designing a proforma and carrying out 5 trial conversations. The conversations were very revealing and thoroughly worthwhile but I struggled to carry them out during lessons as the class were not sufficiently skilled in independent learning to focus on tasks whilst I spoke to individuals. This then moved on to a more paper based approach, initially a 'dialogue' carried out on specifically designed proformas and increasingly through pupil exercise books as pupils grasped the idea.	The questionnaires revealed changes of pupil attitude across the duration of the research; at the end of the project more pupils agreed with the statements 'I enjoy Physics' and 'Physics is one of my favourite subjects' although the boys remained substantially more positive than the girls.	There was a decrease in the number of pupils who agreed with the statement 'I am good at Physics' and fewer boys reported finding Physics easy at the end of the intervention – this may be because they had become more aware of their own strengths and weaknesses within the subject or, more likely, that the Additional Physics we are covering now is substantially harder than the Core Physics which was being studied at the time of the first questionnaire!	I have found the project to be extremely useful in making me reflect on my teaching and providing more meaningful feedback to pupils. I will continue to use the strategies have developed in the future across the groups which I teach. It has also forced me to look more broadly at my teaching style, too many of my lessons do not allow for independent learning which means that pupils were not skilled at doing this when I wanted to work with individuals; this is something I will continue to develop.	The findings from my project, along with some compelling input from pupils at a joint School Council, Governors and SLT meeting last academic year encourages me to continue to try to refine the way that I feedback to pupils in lessons and how we manage this as a Science Faculty. The gender differences in the views of the subject did not come as a surprise to me but the lack of correlation between prior results and confidence with the girls did. I would like to investigate this further, especially with the current Y11 cohort that I have worked with.
Mixed gender, 11-18, 1495 pupils, science specialist; %SEN below the national average; 60% of pupils are of White British background, rest from variety of ethnic backgrounds including Indian and Pakistani ; %EAL higher than the national average.	How can pupils be encouraged to see the study of Physics as a more positive experience? Can understanding the relevance and use in everyday life be linked to aspirations for the future, by showing the careers that Physics is needed for?	More defined roles for pupils while doing group work (inc. practical), leading to them better understanding the specific skills and knowledge being used. A change in focus; improve understanding *before* introducing technical terms. Embedding L2L skills in the science curriculum. Activities focusing on specific careers that involve Physics and the impact of these on everyday situations. We are making a deliberate effort to increase the profile of Physics within the department and the school, as well as providing INSET within the LA – aiming to challenge the attitude of staff that 'physics is hard'.	Questionnaires show a small change in how Physics is seen – seems to be more noticeable with pupils at higher end of achievement spectrum. We were surprised that even pupils who had achieved highly at GCSE had lacked confidence and this had contributed to them not choosing Physics. 6th form interest during open evening (awaiting applications information).		Some of the changes are likely to last (such as specific roles badges for practical work and a greater emphasis on L2L activities) as they require little financial outlay and are supported by school-wide approaches. A change to how Physics is seen – especially as compared to Biology and Chemistry – will depend on the department continuing to take a more active role in activities such as National Science Week, termly Physics G&T Saturday sessions and possibly a Senior (KS4/5) Science Club.	A more systematic approach to how we promote scientific careers is the next step and we are looking at how this can be achieved by better links with PSHE and a greater emphasis within lessons. I am planning to spend a day each term focusing on these ideas and hope to continue the use of (versions of) the questionnaires to check changing attitudes to Physics within the school, with particular reference to able Year 9 and 11 pupils.

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Mixed gender, 11-19, 872 pupils; Attainment on entry is well below the national average, low levels of literacy %FSM well above the national average; large majority of pupils are from White British backgrounds; range of other minority ethnic groups represented. %SEN well above average. Resource base for pupils with hearing impairments.	Does assigning roles in group work increase engagement and attainment? Does a variety of activities increase learning? Is there any difference in the way boys and girls respond to group work?	I decided to research if group work has any impact on pupil achievement and the way boys and girls respond to this. So I chose two year 8 groups compatible in academic ability, work ethics and gender ratio. Both groups had higher girls to boys ratio and girls were more interested in traditional girl subjects. The groups chosen were taught electricity topic for eight lessons. The only difference was a different teaching approach and technique. Pupils were provided with an opportunity to engage with practical work in a variety of ways. Pupils were given an opportunity to work in different settings. Groups were based on ability, friendship, types of activities for different learning styles, paired work, gender	Formal observation was carried out during my research project as a part of school policies and I specified how groups were chosen. The impact of this was reflected in pupil engagement and learning. This was noticed by Headteacher and as a result science department is in the process of looking at different factors while choosing groups for different activities within a lesson.	The research didn't bring any interesting results. Although, it looks quite promising initially but over the time pupils were just not interested and preferred to work with pupils they were comfortable with. There was not much difference in achievement between chosen and control group. The only skill that pupils demonstrated was being responsible. They took care of the job given but this didn't necessarily affect their performance in test. There was no difference in boys and girls attitude.	The change will last for long time. It is in initial stages. Pupils need long time to see the impact of any change. But this is definitely sustainable.	I would like to research science careers for girls as I feel they are not properly informed.
Mixed gender, 11-16, 354 pupils, specialist technology; %SEN well above average; %EAL and % pupils from minority ethnic groups is very low. The school serves a relatively advantaged population, but pupils are drawn from a wide, rural area, which includes pupils from much less-advantaged backgrounds. %FSM below the national average, but well above the local average.	**Does the use of a mapping process allied to Concept Mapping (Unified Modelling Language) assist in both the planning and presentation of topics which are generally considered "difficult"**	**A model of a specific strand "Turning Forces" in the Go Science Scheme of work (Go Science 3, Chapter 5, Calculating Forces) was modelled, and taught to a top set Year 9 class over a double lesson.**	**The class had higher level outcomes for the stand alone Levers and Moments" test, when compared with both FFT-D predictions for the class and with final KS3 results. Many other factors will have pushed the result this high, but observation of how pupils were willing to tackle the questions in the test was that this was very different from the "fear" engendered by similar questions in the past. Whether this ability to complete this type of question persisted was not measured, but when questioned, pupils seemed to have a "correct" view of turning forces and were able to discuss these ideas using scientific language. Pupils enjoyed the practical element, particularly going outside to hang weights on the branch. Pupils who were having trouble with the calculations found the "How to" sheet helpful (although several had to be "forced" to follow it in the first instance!). Pupils also liked the cards**		**Change in personal approach to the developmental process is sustainable and embedded. Change in pupil perception of maths seems to have improved from informal observation of ability to tackle V=IxR type questions recently covered in Year 10.**	**I am currently undertaking a Warwickshire Action Research project which is looking at the use of a classroom wiki to support independent learning, and modelling is involved in developing this. Work continues to map course content. This will be collated as part of the wiki development, but is likely to take some time to formalise.**

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
			with small models on to assist with discussing ideas in groups.			
Mixed gender; 13-18; 1411 pupils; science specialist; %SEN low, as the proportion who are of minority ethnic heritage. %FSM much lower than found nationally.	What effect does offering choice of activities in lessons have on: a) attainment in Physics b) enjoyment of Physics	Instead of a general lesson plan which would normally be used with all pupils, pupils were offered a choice of 5 activities which addressed different learning styles, of which they could choose 3.	Pupils took more personal charge of their learning General enjoyment of boys was improved. Noise levels did not upset pupils Unexpected was that readers can concentrate with video, computers and practicals going on around them!	The classroom is a lot more noisy because of the diverse activities! Girls were only generally happy if they could repeat options – reading and doing questions Key point is that this is not a technique to use for all units on the course. Best to use selectively. Also, it could lead to behaviour management issues with certain groups as difficult to manage unless pupils are trustworthy	Sustainability short term since now year 11. Some have learnt to better manage their own learning though, which will stand them in good stead longer term. The downside is that some pupils develop bad behaviour – this has to be carefully managed from the outset. It really depends on the group	Repeat with same group this year Repeat with similar group this year Try with a different type of group to assess effect on lower ability group Try with AS group
Mixed gender, 11-18, 1235 pupils, specialist technology; % from minority ethnic backgrounds and %EAL is above average; %SEN above average. School has a dedicated centre, for pupils with autistic spectrum disorder. Levels of disadvantage %FSM average.	How can I show pupils that physics is an interesting and useful subject How can I increase the number of (suitable) pupils wanting to take physics at A-level	The main change is the teaching scheme. I have been running some 'cutting edge' physics lessons as an 'extra' to the regular curriculum lessons that the high level y10 pupils are receiving. Also we have started to run an astronomy club after they received the astronomy lesson that I did for them. This is then going to hopefully develop into GCSE astronomy for those who are interested.	The impact of the intervention so far is difficult to gauge at this point. However I do believe that I have managed to raise awareness of what physics is about and raise interest within the subject. Many pupils volunteered to take part into the optional activities (CERN video conference and Astronomy club) which shows some interest is there. Also I have had good feedback about the extra lessons that I have put on.		I believe that this change is sustainable and repeatable every year. As once I have been through the process once I can evaluate and improve it before running it again.	I plan to use the ideas developed this year and forge them into a structured yearly plan that can be built into the main year 10 and 11 scheme of work. I also am planning on the continually reviewing this plan to ensure it remains up to date with new physics and as interesting as possible for the pupils. I would also possibly like to investigate how to tailor part of the scheme to girls as I am aware that much of what I have done and plan to do does seem to appeal more to boys.
Mixed gender, 11-16, 750 pupils, CofE/Roman Catholic, specialist humanities; Pupils from a wide range of backgrounds, but many have more advantaged	How confident are pupils at answering questions? Does 'no hands up' and increased wait time increase confidence in answering questions and hence improve enjoyment of lessons?	I incorporated 'no hands up' for question and answer sessions – initially choosing pupils at random myself, but progressing to using a random name generator power point with the target group. I trialled setting 'plenary' questions at	The girls enjoyed the first careers notice board setting up sessions. A girl and boy were asked at random if they found the technique (questions known in advance and then used as a plenary) helpful, the girl said no, she couldn't answer the	I gave the pupils in the target group a 'post intervention questionnaire' but this was not completed sensibly so I was not surprised that it did not reflect any positive	I have been trying to include 'no hands up' and increased wait time with other groups but have found it difficult to maintain. I think it will take quite a while of	I will continue looking at the book I have bought on Evidence Based Teaching and will try to incorporate more of those techniques into my teaching. Hopefully I will also

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
socio-economic circumstances than average. %FSM lower than usual; %SEN broadly average, The numbers of pupils from minority ethnic groups average, and 35 are at an early stage in learning English	Does this then lead to greater intention to continue with Physics to 'A' level?	the start of the lesson, collecting their answers in, and then using the random name generator to go over the same questions at the end as a plenary and summary for them to keep. I have changed this to just giving 'plenary questions' out at the start and using the random name generator to go over these as a plenary. I tried to allow increased wait times for my question and answer sessions. I also encouraged the girls in the target class to make a display of 'careers in physics' to try to raise their appreciation of the applicability of studying physics at 'A' level.	questions at the beginning so what was the point, the boy said, yes it was very useful to know what in particular to attend to. Following a later lesson with just plenary questions, one boy pupil said 'This really helped me to understand'.	change in attitude. The group have been under pressure recently to complete the content of the course before the mock and this may have affected their answers. I intend to hold a focus group interview to see if I can detect any changes in attitude that were masked by the unsatisfactory answers to the final questionnaire.	practicing this before it becomes a good habit. Hopefully, once it has become a habit, I will use it continually, and only change it occasionally for valid educational reasons. The careers notice board for girls I will continue with a year 10 group from summer term next year and so on into the future. The plenary questions I will continue with and hope to extend to other groups gradually. I will try to gauge if it is more appropriate with a particular age range or ability. I will experiment with different amount and type of questions.	improve my use of 'no hands up' and increased wait time! I am also going to try and increase my use of 'open questions' and have put this down as my goal for my school coaching (improving my teaching practice) inset.
Mixed gender, 11-18, 1222 pupils, specialist maths and computing; Most of White British heritage, % from minority ethnic backgrounds is well below average. %SEN well below average. The range of special needs include specific learning difficulties such as dyslexia, moderate learning difficulties, autistic spectrum disorders, emotional and behavioural difficulties and visual or hearing impairment.	I decided to increase the proportion of the lesson dedicated to the demonstration and review of learning. The desire was to increase confidence in learning and to allow relevance to be explored in depth, and to increase girls' confidence in speaking up in discussions. Additionally, I wanted to better synthesise these opportunities with AfL through questioning and the training of Higher Order Thinking skills into my teaching by time talking individually to pupils.	My intervention was with Year ten pupils in the Summer term. Prior experience with CASE materials (Adey *et al*., 2001) and the Accelerated Learning planning cycle (Smith, 2006) provided me with a format for lesson planning which would allow me to design time into each lesson to develop HOT skills and engage in effective AfL questioning and, most importantly – building a spirit of cooperation. Each lesson, in the sequence of 10, was designed to have at least 30 minutes where pupils were engaged in self-managed learning. During this time, I explored pupils' interests, how I could make the physics relevant to their learning and explore potential career options. I sought to achieve this through the use of Socratic questioning and the development of Higher Order Thinking. By investing in	General comments in the Focus Groups appeared to indicate that pupils were more likely to consider a Physics / STEM career as a result of having the chance to see how physics is linked to their daily life, or to worldwide issues, or to other subjects in their lessons. Class assessments performance are at least on par with expectations, if not slightly above this. Applications for 6th Form Physics studies are higher than any in recent memory with average applications in the previous five years being around twenty pupils in total with less than one in five pupils being female. In the current cohort, only looking at the number of pupils who are definitely going to pursue Physics (subject to grades) we currently have 48	Males responded less positively than females to the use of small group and individual interventions. In most situations the female pupils were happy to continue working as I worked with an individual pupil at a table. However, the male pupils seemed to be more easily disturbed and often sought to join in the discussion, or simply listen rather than complete the task they were supposed to be engaged in. It is hard to see how baseline GCSE results will be affected by this intervention as the		Based upon the findings of this Action Research I would be keen to see how this type of intervention could become a regular feature of AfL within the Science department as it not only allows pupils to formulate their own 'next steps advice' but it allows the training of Higher Order Thinking skills in a highly personalised manner.

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
		the personal relationships in the class, I was able to identify areas of interest relevant to the pupils upon which I could build future learning sequences.	applications including more with just under one in three pupils being female. Numbers of pupils from Set 2 (my class have historically been around two to five pupils) are now nineteen applicants from this set.	assessment window will be in January 2011.		
Mixed gender, 11-18, 1810 pupils, CofE, Specialist technology; Just under a half of the pupil population is from White British backgrounds; rest from a range of British minority ethnic backgrounds. 22% early stage of speaking English. School serves some areas of social and economic disadvantage, %FSM greater than average. %SEN above average.	How are teaching and learning strategies being used to engage pupils with Physics? How can the classroom be managed to promote pupils' engagement in Physics lessons? How can careers be included in Physics lessons?	Series of lessons on energy and electricity carried out with triple science (i.e. Physics GCSE pupils). Lessons incorporated greater group work, independent learning, practical skills, careers information, multimedia. Additional training in key concepts for non-specialist Physics teachers. 'Careers in Physics' display in corridors at both campuses. Guest speaker to promote applications of Physics to all Y10 pupils.	From my observation: pupils were more involved and played a more active role within the lessons. From feedback from questionnaires: The majority of the pupils enjoyed the group work approach to lessons and the freedom to select the order in which they completed their tasks Pupils were better able to name careers related to the Physics studied. Pupils achieved their target grades in the exam questions set in relation to this area of the topic. The new lessons will be implemented next year.		Schemes of Work have been re-written so lessons can be rolled out to all Y10 pupils. Contacts maintained with guest speakers to come in on a yearly basis Further training arranged for non-specialist teachers.	As a result of the project, the faculty has invested in a lot of new Physics equipment. I would like to rewrite schemes of work to incorporate new practical and demos. It would be interested to assess the impact of this on enjoyment and uptake.
Mixed gender, 11-18, 1110 pupils, Voluntary Aided Roman Catholic, science specialist; most pupils of White British heritage; %SEN low.	'Does co-constructing Physics lessons with female pupils improve their engagement and learning capabilities?'	I planned a series of 6 lessons with female pupils in an aim to increase personalised learning and enjoyment and engagement during the lessons. Using the ideas from the pupils I adapted the lessons to suit the learning styles generally preferred by girls; project work, small group discussion. I used more active learning methods to try and make physics more relevant to girls' interests so they could make the links of how physics fits in with the world. I made use of more group discussion before giving answers, and use of mini whiteboards to feedback responses. I have tried to use more 'stories' and examples that are related to the pupils' lives, and link to current issues in the media. The scheme of work for forces and motion was completely revamped. It contained YOUTUBE clips from top gear, Olympics, current modern science documentaries	my classroom interactions were aimed equally between boys and girls. The initial highlighted areas were the enjoyment and progression with physics in everyday life. They struggled to make links with ideas and understand how physics fits in with the world around them. However, throughout the project I have observed, and evidence from the questionnaires has proved, that girls are more interested than boys in the social context of physics. They did enjoy the teaching strategies implemented and it has increased enjoyment and engagement in lesson. However, this was not successful enough to increase post 16 uptake instantly. Overall, the project has allowed the department to gain a raised awareness of gendered dimension to teaching and learning, and hopefully allowed teachers to feel more	When asked on one-one interviews after the 2 cycle questionnaire process, pupils still said that they did not want to take physics post 16 as they didn't require that subject for their chosen career. This then identified a major new intervention strategy which needed to be put into place, which was one that focussed more on careers and progression within physics. In addition, the clearly successful ideas such as those implemented relating to the engagement and enjoyment need to be incorporated much earlier in the science curriculum. It is essential that this	I feel that these changes need to be trialled over a long period of time as the term 'action research' suggests that it is a progressive process.	I intend to promote whole school awareness of gender issues in education, so hopefully they can join in the success of new approaches in teaching and learning. This will include the following ideas: Raising awareness of physics issues with careers advisors to include guest speakers and workshops Looking for opportunities to organise visits to workplaces relevant to our GCSE/KS3 scheme of work Looking for posters showing science careers Updating and promoting the Physics careers board in the science department Raise awareness with Maths to highlight links when discussing A level

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
		and Hollywood movies. In place of their normal science lessons, year 10 and 11 pupils received a one-off lesson aimed at illustrating career pathways open to those with a physics qualification and promoting the relevance of physics to everyday life by producing a project and presenting to fellow peers. This included salaries, prospects and entry requirements for specific careers. These were then displayed within the science department on a physics careers board.	confident and competent teaching physics to engage girls. Whole school, it has promoted effective gender aware classroom management and teaching and learning strategies.	happens before pupils have made their choices of possible careers and for us then to embed the physics progression and careers alongside this teaching at KS3.		choices Raise awareness to all Science teachers of issues so they can develop cross curricular and include career links to all Schemes of Work Develop and highlight Medical Physics at AS level. (i.e. Highlight Medicine requirements) Deliver A level information and taster lessons to Yr9-11 throughout the year
Mixed gender; 11-18, 1118 pupils, specialist arts; % pupils from minority ethnic groups, %FSM and %EAL are above the national average; %SEN below average.	What are the reasons for the lack of girls studying Physics at A level? Does the approach to studying Physics affect pupils' interest/engagement? What activities in the classroom and extra curricular events can be used to address this issue? How do pupil perceptions differ between girls and boys?	Activities undertaken in GCSE Triple science lessons for the P1 - 7 modules The approach taken in the P4, 5 and 6 modules was to structure the scientific content around particular contexts, (e.g. car safety, demand for electricity/energy and its impact on the environment) creating appropriate new resources and activities and adapting existing activities accordingly. It was also planned to put pupils into single gender groups in one class and use mixed groups in the other to examine whether this had any bearing on interest and engagement of girls.	Early questionnaires seemed to indicate that pupil perceptions weren't as negative as we feared. Throughout the process it seems that interest and engagement in the subject remained high but the perception that 'they couldn't see themselves in a career connected with Physics' was the major reason girls would not be selecting it as an A level. Relevance of activities definitely influenced the engagement of girls but harder to ascertain effect on performance. Many activities have been adapted for incorporation into schemes of work. Results in modules so far have been very good. Some pupils have come to regard themselves as 'better at physics than the other sciences' whereas before they were at the other extreme. Equally this doesn't directly translate into intention to study it further, merely motivation to study hard for the exams.		It is hoped that the changes will be permanent but obviously they need to be ongoing to steadily increase the number of female pupils until the 'stereotypical image' has been eradicated. I am currently working with the next 2 groups of Year 10 triple science pupils to continue the project so any gains from the first year group through can be built upon next year.	It will continue with the next triple science groups in order to build on any improvements this year as it is definitely going to be a long term project to change the current situation. It has been most intriguing to me the difference in teacher and pupil perceptions and how to reconcile the two.
Mixed gender; 11-18, 1504 pupils, specialist arts; % pupils from minority ethnic groups and %EAL below average. Many pupils come from average social and economic circumstances. %SEN	Does the setting of work in context affect the way its relevance is viewed by Key Stage 4 pupils? Does the contextualising of the Physics content increase the uptake of A level Physics?	When teaching aspects of the 'Forces and Motion' and the 'Electricity' modules I started 4 topics by looking at real life situations linked to the content that was to be covered. When teaching the content I constantly referred back to the applications to enable the pupils to see the relevance of the work to the	On a personal level I have enjoyed teaching the topics more in this way and by starting with the applications it has made it easier to make the relevance of the work more explicit by constantly refer to applications during the unit. I have noticed a greater engagement	After the intervention the level of interest expressed in both Chemistry and Biology decreased, whereas the level of interest expressed in Physics increased (from 12-33% for girls and 48-	Whether the final outcomes suggest there is an increased uptake of A level Physics as a result of this change I feel the other impacts of the intervention, increased engagement	First I need to continue collecting data for the research group and the parallel set up to the start of the A level course to assess the effectiveness of the interventions. I intend to carry out a

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
similar to that normally found.		real world. Previously when teaching these units I have started with the key ideas and drawn them together at the end of the module by looking at a variety of applications.	in the work from a number of pupils, with more of the girls being prepared to answer questions in class and ask about the work. The final outcome will be clearer when the exam results have been published and the pupils actually make their choices of A level courses. One outcome I have found is that the amount of interest shown by these able pupils, especially by girls at the start of KS4 was very low. I am going to carry out a future project to see if I can tackle this issue at KS3.	70% for the boys) A similar pattern was shown in the proportion of pupils stating their intention to study Physics at A level.	and a more positive view of the relevance of Physics, are valuable in their own right. As a result I will continue to take this approach with future groups of pupils and will produce a series of lesson plans so that colleagues can also do this with their classes.	similar project with a KS3 set over years 8 and 9 to see if their attitudes towards Physics are different at the start of KS4 and if they are to continue to follow the progress of these pupils through KS4.
Mixed gender, 14-18, 1216 pupils, specialist technology; %SEN, %EAL and %FSM below the national average; A small proportion of pupils at the college are from minority ethnic groups.	What are pupils opinions of the teaching of Physics at the school? What are the staff perceptions of the teaching of Physics at the school? How good is the quality of teaching and Learning at the school?	Scheme of work for P1 and P2 modules updated to include more activities for pupils, observation undertaken of other staff teaching lessons in Physics, in particular non-specialist. Planning lessons with non-specialist staff to observe changes in pupil attitude to physics when lesson is given a new context. New demonstration equipment bought.	Move towards more activity based lessons has begun . . . ., particularly in Physics. Response from pupils when the lesson is placed in a relevant / real life context. e.g alpha radiation and Litvinenko poisoning, Turin shroud and carbon dating in radioactive decay: both lessons enjoyed by pupils. My Assemblies on Careers in physics were noted as being stimulating for pupils; positive comments from other staff and pupils. The intended observation work has only just begun really and I intend to restart this aspect this academic year. One surprise outcome is I have begun to question the suitability of our AQA GCSE course – content and assessment procedures - for the majority of pupils at GCSE.		The context based schemes of work in Physics are embedded in the faculty and being used by the majority of staff teaching physics as non-specialists. Some staff still/will need training in use of new equipment; a long term development I hope.	Improve corridor displays showing the relevance of Science in the 'real world'. Consider changing GCSE course to a more context based specification when starting the new GCSE in September 2011. The purchase of new equipment to improve the use of data-logging in Physics lessons at GCSE and A level.
Mixed gender, 11-18, 1348 pupils, specialist humanities and arts; serves a widespread and mixed community. Most pupils are of White British heritage; %EAL low ; %FSM high; %SEN above national average. The school is a local authority resourced base for a very small	Why is the number of girls taking A level physics decreasing each year? What are pupils' perceptions of secondary science? Is science given enough relevance in the classroom?	I have begun to adapt the curriculum to make certain aspects more relevant to pupils, including explaining the context of the learning in the real world such as nuclear power and electric circuits I have also formed a science research group from year 11 pupils to assist me with my research and also to provide a program of events to help them gain a better understanding of science in the real world.	Pupils', especially some girls., interest in physics has been improved and results in the latest GCSEs have been improved significantly Pupils attitudes to physics lessons have improved as the purpose for their learning is made clear to them at the beginning of each topic. By using the idea of a Big Question and a Bigger Question at the start of the topic, pupils are now encouraged		Change in the classroom is expected to become permanent and will be evaluated and improved biannually The use of a research group in future years will depend on the outcome and if successful will be maintained for both the	I will be continuing my research as part of the MTL after ARPP is finished and hope to extend the project to look at other aspects of Action Research during this time, including possibly investigating the use of ICT in Science education as an alternative classroom resource.

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
number of pupils with visual impairment.			to consider the relevance of their learning as well as the larger impact a topic may have on them on individuals.		high achievers as those who have the potential to improve.	
Mixed gender, 11-16, 1039 pupils, Roman Catholic, specialist science; %FSM and %SEN below average; 63 EAL pupils at early stages.	What attitudes do pupils have towards using computer software (notably simulations or revision materials) to try to improve their understanding of key scientific concepts when such work is performed in the home?	I assessed the current attitudes to science, IT and learning of a year 10 separate science group using previously established tools, self-generated questionnaires and interviews. I have worked to establish a whole series of learning and revision resources that have been and are now available to the pupils on a permanent basis from home. From these resources I selected a few for them to look at and work from at home. I have collected comments on the simulations and the attitudes of the pupils thereafter.	I think the impact is going to be more medium term. In the groups I worked with clearly all are more aware of a different strand they can pick up when addressing their studies and their revision. This I feel will help them – as they do, evidenced by their comments. As a study I am closer to realising where online learning is best focused for my department – this includes learning of the limitations of myself, my colleagues, the pupils and the technology. As the project is wider than this research (i.e. providing online resources for all year groups) evidence that others are using the online resources is also encouraging and I have experienced a full range of feedback – from year 9s seemingly accessing everything to year 11s who don't know why I bother.	I am surprised by the extent to which I now believe training is necessary. I think I take for granted that pupils can use ICT significantly better than myself and navigating around things like Learning Platforms is easy for them. I now doubt this assumption.	As long as I am in the post and the learning platform is funded/available it will be used. Purchases I have made are all permanent (i.e. not subscription). I suspect we will use it for as a repository for revision materials rather than use it for online homeworks or regular weekly work in the short term, but maybe over time this may change too.	I will complete the intervention with my initial group of year 10s. After this I will reorganise the science area of the Learning Platform to be more clear to pupils and be more inclusive. Future purchases will focus on content and coverage rather than week-by-week online tasks. I need to consider how to launch the content such that all are aware and minimal technological problems (from my part) are incorporated.
Mixed gender, 11-18, 1226 pupils, specialist maths and computing; Most pupils are White British. %FSM well below average. %SEN average.	**Does the provision of concept maps affect learners' enjoyment of subject and confidence in achieving?** **Does the provision of concept maps affect** **exam results** **pupil enjoyment** **pupil interest in doing A-Level physics**	**I produced a concept map of each physics topic studied in year 10 and 11. The pupils received a copy of the concept map at the start of the topic. They were asked to mark the concept map in some way when that aspect of the course was completed and then again when they had revised that concept.**	**I think that the intervention has had some impact. Analysis of my questionnaires has found the following results:** **Boys confidence in getting their target grade has risen by 15% (no significant change for girls)** **There is a 18.8% increase in pupils wanting to follow A-Level physics** **Results have been consistent for the physics exams, before and after the intervention the average class grade has been "B". However it is worth noting that the biology and chemistry results for this same class have decreased from the first to the second exam. It could be that the concept maps have had some effect on pupil results.** **One unexpected result is that the**		**Now that the concept maps for three of the seven topics are prepared I plan to make them available to pupils and staff via the VLE. I want to encourage my classes to use these concept maps as I believe that they are beneficial to the pupil's confidence and understanding.**	**I plan to continue using the concept maps in lessons. I want to develop my skills so that I am able to link resources to each concept and become more interactive. I also plan to produce concept maps for the other topics in physics. I remain interested in using concept maps in education.**

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
			member of staff teaching these topics wanted copies of the concept maps. They used them to assist in their planning of the topic. (I asked that they were not issued to the pupils until I had finished this project.) Also I think I have found a way to link resources to the concept maps – so that in the future pupils can "click" on the concept and be provided with notes / questions etc… for that area of work.			

Classroom Management Interventions with some impact

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Mixed gender, 11-18, 1543 pupils, specialist sports; %SEN above average. Proportion of pupils in public care well above average. A very large majority of pupils are of White British ethnicity.	How can I motivate a group of very low ability year 8 pupils who seemed to be completely uninterested in science and who amongst them had so many issues other than a willingness to succeed in school or science? How can I make them interested and want to learn any science? How can I improve their behaviour? How can I get them to achieve their target grades at the end of the year?	I introduced something I called 'cool science.' This was a range of practical activities rather like a science club which were loosely based around the curriculum (sometimes there was no clear link between the activities and the curriculum) but I needed to get the pupils 'on side' and make them interested and curious about science. I felt that it was better to *teach* them something instead of just allowing them to fail in the year 8 content.	Of the 17 pupils I started the intervention with 4 left group either because they changed school or because they were permanently excluded from school. 2 other pupils joined us because they were moved from another group in the school. Of these 15, 5 achieved 1 sub level above their end of year target and all but 1 pupil achieved their end of year target. All pupils became far more interested in science and the intervention inspired them to ask questions about science such as 'how things work' and 'how did scientists know how to do that', 'what could we use that for.'		This particular intervention is short term. I no longer teach any of these pupils now that they are in year 9. I see some of them from time to time and they seem to have lost interest in science again. They say they don't like their teacher, that science is boring and they never get to do any experiments.	I would like to investigate the possibility of introducing more tangible science in KS4. There are opportunities in the BTEC course but it would require input from several other teachers to make it work. I concentrated on the science I know and would like to explore the ideas of biologists and chemists.
Mixed gender; 11-18, 1688 pupils, specialist technology; The great majority of pupils are of White British heritage and speak English as their first language. %SEN average.	How does a greater emphasis on the human aspect of scientific inquiry through the use of small group discussions affect pupils' engagement in physics lessons? How does a greater emphasis on the human aspect of scientific inquiry through the use of small group discussions affect pupils' views of the nature of science? Does this also result in more pupils wishing to study physics post-16?	I designed, or sourced, and implemented small group discussion activities in my triple science physics lessons.	The pupils seemed well engaged in the small group discussion activities. The girls joined in these discussions much more than they do in whole class discussion activities. Several pupils actually told me that they enjoyed the discussion activities after one of the lessons that included this. Their responses to the questionnaire items about small group discussions were overwhelmingly positive; pupils felt that the small group discussions helped them understand physics better and the majority indicated that they enjoyed having the opportunity to share ideas with each other. Several pupils commented that poor behaviour of their peers was a disadvantage of working in groups. My practice has changed to include more pupil-focused activities. I have developed some useful resources for supporting small group discussions which I discuss further elsewhere. It is too early to make any definite conclusions about the impact on the numbers of pupils choosing to study physics post-16 but a cursory glance	One of the discussion activities was not very successful at all because it was too difficult for many of the pupils to access. Revealingly one pupil complained that it was too difficult and that "we're not scientists, you know". I strongly believe that learning about science should also involve pupils learning how to model the work of scientists. There was no significant change in pupils' views of the nature of science over the course of the intervention. Pupils actually had fairly sophisticated views of the nature of science at the start of the intervention (many were aware that scientific knowledge develops over time, that scientists need to use their imagination to make theories and predictions	I have altered my teaching to include more small group discussions. This is likely to last and, if anything, actually increase and improve over a longer period. I have made more use of small group discussions with the research class and with other classes at both KS4 and KS3.	Many pupils indicated that they would enjoy the small group discussions more if they also included opportunities to plan and carry out experiments related to the problem solving together as a group. I will try to develop activities that include this practical element along with the discussion activities.

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
			through the "feelings about physics" questionnaire revealed that about 30% of pupils may choose to study physics post-16. Unfortunately very few of these are girls. Perhaps there were too few opportunities to use small group discussions to have a major impact on the attitudes of the pupils involved in the research.	and that interpretation plays a role in the construction of knowledge) so any significant gains would have been unlikely.		
Mixed gender, 11-16, 878 pupils, specialist B&E and Arts; situated in a community which has much higher than average levels of deprivation; %FSM almost double the national average; almost 80% of pupils originate from minority ethnic heritages, mostly Pakistani and Indian; around a fifth of pupils are White British. %EAL very high; %SEN broadly average.	Does gender play a role in the learning of Physics?	I split the class into groups by gender, and taught a mixture of gender specific tasks and lessons. Sometimes the genders collaborated, others they competed. They always fed back their work to the whole class to ensure continuity/smoothness of learning.	The subject group had a more positive view of the subject and found it more relevant and interesting. They also were more inclined to think that the gender of people they worked with made a difference though **the teacher** rather than the **gender** of the teacher made a difference. (see attached sheets for details) Unexpected outcome – we more than doubled or applicants for triple science in year 8 (started year 9 2010), and now have two groups.		With full dissemination to other staff, it could become a permanent feature of our Physics teaching. It would certainly be a good test of validity and could potentially increase reliability. Certainly in my own practise it can become permanent.	I wouldn't mind developing my research to look at gender specific role-models in Physics and the impact they may have. I would also love to have the time and resources to create a bank of gender specific resources and lessons

Progression Interventions with some impact

School Background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Mixed gender, 11-18, 1608 pupils, Sports specialist status, pupils mainly from White British backgrounds and few EAL. %SEN broadly average.	The focus of the research was 'breaking down the barriers to progression by looking at the bigger picture and how the topics in physics related to the world around us'. This research was focused around questions such as: Do the pupils see a relevant/real life picture? Does the topic seem pointless? Are pupils able to link the topics in physics with the world around them? Does the way in which certain physics lessons are approached make the pupils 'switch off'?	A number of interventions were carried out with the focus group. Each intervention was the result of an original question asked when identifying the research to be carried out. 1) Careers Lesson To look at the question 'Do the pupils see a relevant/real life picture?' a stand alone lesson was produced concentrating on careers in science. The lesson aim was to assess pupils current understanding of science careers. The lesson was carried out in a computer room with every pupil having access to a computer and internet facilities. They then completed an A-Z of careers involving science before any discussion. Pupils were shown an institute of physics document to get them thinking about where science is used and then asked to research science careers via a few specific websites. 2) Links to the real world To approach the complex issue of 'Are pupils able to link the topics in physics with the world around them?' a number of small low key interventions were put in place/used to link school and the 'real' world. One of these small interventions was a mini project in class focused around electricity. Pupils were coming to the end of the electricity topic and this project was aimed at bringing together all of their recently gained knowledge in an everyday context – a working environment and a business issue. Pupils needed to work as a team and use a variety of skills to decide on an outcome to present in the business scenario.	Initially 17.9 % of pupils stated that they knew which career they wished to pursue after leaving school. This number changed to 10.7% after the careers lesson. The number stating that they did not know which career to follow remained the same. 85.7% of pupils stated that they found the careers lesson enjoyable. When asked 'Would knowing about possible careers motivate you to do better in associated lessons?' 46.4% initially said yes compared to 35.7% after the lesson. 7.1% said no compared to 3.6% after the lesson and 53.6% answered possibly initially compared to 60.7% after the lesson. As expected the number of pupils answering Yes to 'Do you ever discuss science careers in careers lessons?' increased from the initial to the final survey however 37% of pupils answered 'no' after the careers lesson. All of the pupils who attended the pupil interview had generally positive comments regarding physics and their science learning. They enjoyed learning about things which they perceived as relevant to them but did not like repetition of topics that in their opinion they had already covered. Over 80% of the focus group have gone on to study triple science, a similar uptake to previous years.	Drawing information and a conclusion from these recorded interviews proved very difficult as pupils were still quite general in their answers and opinions. It appeared that the pupils also felt obliged to be positive about the subject due to the fact their teacher was asking them the questions. Although generally information was gathered, collection of this data and it's relevance is difficult to collect. What cannot be determined from this project is the number of pupils that would have chosen the triple science option without any intervention.		

School Background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
		A second intervention was a large display placed within the science department explaining the work being carried out at CERN.				
	How can I raise pupil's awareness of which areas of Science come under the 'Physics' heading? How aware are pupil's of the career options opened up to them by studying Physics post 16? How interesting do they find physics?	I worked with an able, top set Year 9 group of 30 pupils. I included a module on Physics career paths in their last term – pupils produced a display to inform others of their findings. Invited visiting speakers from local community e.g. ex pupil who is a nuclear engineer, parent governor who is electrical engineer. Ran sample lessons to relate GCSE physics to the real world.	47% of target group are taking Physics GCSE this year is instead of double award science compared to 23 % of equivalent teaching group with whom I carried on the normal curriculum. Before careers module, pupils on average came up with 3 ideas of where Physics A- level might lead. When asked again at the end of the year they averaged 8. Changes in department and classroom; Far more explicit in naming areas of science we are studying. I (as the physics specialist) now teach physics topics to all pupils in each year group by using a rotation system. Links with visiting experts maintained – parent governor (electrical engineer) runs regular sessions with Year 7 Science Club. Continuing with careers work at end Year 9. Permanent display of physics career opportunities in prominent position.		The changes in practise are sustainable and seen as desirable by myself and my colleagues in the Science department. We intend to continue with the rotation system to ensure that pupils have expert teaching in Physics and having outside input to Science Club is welcomed by pupils and staff alike.	Changes in department and classroom – plan to; Be far more explicit in naming areas of science we are studying. I (as the physics specialist) will now teach physics topics to all pupils in each year group by using a rotation system. Links with visiting experts maintained – parent governor (electrical engineer) runs regular sessions with Year 7 Science Club. Continuing with careers work at end Year 9. Permanent display of physics career opportunities in prominent position.
	Does the lack of understanding the relevance of the topics hinder learning? When relevance to day to day is linked to the topic, do the pupils display any enthusiasm for more / continued participation in the lesson? Do the Maths sets play a part in Physics progression? (Will being in a lower set in Maths affect the pupil's ability to progress in Physics?)	A dedicated and visible area was set up in the laboratory, highlighting relevance of day to day living to the topic. The lessons became more interactive with pupil participation being the focus. For the year 9 physics topics – Speeding up and Pressure and Moments, hands on practical activities were carried out. A real see – saw in the lesson with the pupils trying it out to carry out "moment" activities, then applying the learning to the calculations. Using a wheelbarrow in a race to move heavy weights to illustrate how we use Physics concepts without realising that they are. Using actual cars on the road to look at speed before applying it the lesson to	The most significant and quantifiable impact of the intervention (from survey analysis and pupil interviews) is that 40% more pupils preferred Physics to the other Sciences. There is an increase in the percentage of pupils who will do Physics regardless of the Math contents and will be more willing to attempt problems in Physics particularly when calculations and equations are involved. We have a higher uptake of triple science than ever although the real impact of the intervention will not be truly realised until 2012 An unexpected outcome is that the intervention appears to have confused the pupils who were sure		The intervention will continue, for the pupils who have elected to study triple Science. This means that the changes will be sustainable until 6th form is attained. A significant % of pupils now agree that studying Physics is likely to give them a more secure future. This leads me to believe that the changes will not be	I would prefer to stay with the 2 areas of intervention I have started with. During this time, I will make attempts to ascertain from the pupils other reasons for the lack of enthusiasm for Physics and then armed with the tools I have gained from this research, carry out discrete action research projects. I will need to look again at the notion that Physics is too difficult from pupils who are predicted A* -A

School Background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
		demonstrate relevance of topic to day to day.	they knew that they would NOT do Physics after GCSE's. There was a significant shift to the "don't know" responses to the question about knowing what they wanted to do after GCSE's. This may presume that the pupils have had a rethink as a result of the intervention and may well choose to take Physics further.		short term; however, one disappointing theme that came up was that Physics was a more difficult subject than all the other Sciences and it was possible to achieve a large proportion of the careers featured without studying Physics.	and plan interventions to show the pupils that it is a perception.
Girls' School; 11-18, 1217 pupils; specialist Science with Mathematics; has a large sixth form which forms part of a consortium with three other neighbouring schools. Predominantly White British and Black British African pupils, which make up about a quarter each of the school roll. %FSM and %EAL above average; %SEN below average, mainly dyslexia and behavioural, emotional and social issues or physical, speech and hearing needs.	Aim- To change pupils' impressions of physics for the better and improve uptake at A level. Do the pupils know what Physics is and how is it important in the world in general? How can we increase the uptake of Physics at A level? What careers are available to Physics pupils?	Raised awareness of links to Physics in the real world. (structures and jobs) Gathered "entertaining" resources/video clips. Purchased practical equipment. Created different groups for practical work and written work. Entered "Water Rocket" competition. Formed links with Bloodhound. More context based work.	It appears a significant number of pupils have changed their opinions of physics; sadly some pupils still aren't fans. Exact percentages will be available later in the term. A small percentage of the y8 class expressed an interest in studying A level physics. Of the same y8 class, pupils arrived in class with a more positive attitude, asking what are we were going to do and what groups are we in. On the 6^{th} form open day last year we focused on practical work, linking to real situations and the response from visiting pupils was positive. We currently have 25 pupils in y12 studying Physics.		I will continue adapting my teaching to include links to real life situations and hope it will be sustainable. Since September I have started teaching Physics to a mixed ability y7 class and 25% of the pupils I've asked love the subject and a number of them even said they would like to continue into A level.	Wherever possible I will try to link physics to real life and everyday projects, especially if they are inspiring. I think it is very important that pupils know the relevance of physics. Biology is a popular subject and I think this could be because it's much easier for pupils to understand its relevance. So I will be on the lookout for physics enrichment activities. I have found the project very interesting and would like to continue it on some level.

Combined Strand Interventions with some impact

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Mixed gender, 11-18, 1658 pupils, sports specialist, rural comprehensive, most pupils White British heritage; low %EAL, %FSM below national average; %SEN above national average.	Does mixed gender and attainment grouping affect the level of focus in physics lesson?	L&T and Classroom Mgt The class will be split into mixed gender but also attainment groups using FFT data. The class is 8x2 with an attainment range of 7 to 5. Pupils will be mixed in ability in the groups.	The grouping of the class highlighted structured learning that focused and built around pupils existing concepts and understanding rather than teaching to the test. This showed progression mainly in pupils with FFT level 5, as they were asking high attaining pupils' questions and gave the opportunity for pupils to be taught by pupils. Removing the rigidity in the approach to the physics topic, it allowed time and space for conceptual development and encouraged integration in the mixed gender groups. The higher attainment pupils enjoyed taking a 'teaching role' in the class and making decisions on how to approach the topic, it did consolidate their learning but also encouraged other skills (presenting etc) that they might not have done in a normal science lesson. As pupils had more control over how the lesson ran through the project the interest and focus was maintained for the majority of the three lessons due to the responsibility being on them.		I think that this could be used regularly in lessons and can be incorporated into everyday lessons.	Not sure!
Girls' School, 11-18, 1233 pupils, specialist technology, serves a very diverse community; % well above the national average; 2/3 pupils of non- White British heritage; 50% EAL; 59 languages spoken (largest group speaking Bengali); 18%. refugees or seeking asylum (from countries including Kosovo, Somalia and Afghanistan). %SEN slightly higher than the national average.	How can I increase the confidence of girls in my Physics class? How can I increase their interest in Physics?	Progression and L&T On the basis of the questionnaire, more time was allowed for pupils to think in lessons, allowing them to consolidate things for themselves and empowering them to feel more confident about the subject. To increase their interest/awareness of Physics in everyday life, and to raise the profile of Physics, I used a scheme of work to prepare pupils for the Case Study part of the topic. I had written this with the borough science consultant for pupils doing double science to include explicit teaching of the skills needed to write	the number of pupils who think Physics is rarely linked to everyday life in lessons has decreased to 6/20 = 30% and the number of pupils who feel they do not have enough time to think things through in Physics lessons has decreased to 11/20 = 55%.	However, in spite of these measured outcomes, the impact upon pupil's confidence with Physics and their interest in the subject appears to have been minimal. The difficulty in controlling other factors makes drawing conclusions from these data difficult. For example, as well as changes to the teaching groups, the content and focus of the course in Year 11 is very different to Year	Changes to schemes of work will be long-term and used by teachers across the department in subsequent years for as long as they are relevant to the specification being taught. Changes to my practice, based on what I have learned about an action research-focused approach will also be	In September, I conducted the initial survey with my new Year 10 Physics teaching group (2010-2011), in order to establish what their perceptions and needs were at the start of the GCSE course. I intend to use this to focus on achieving the eventual aims of this intervention – to increase uptake of Physics at A Level.

		the Case Study, but also to excite them about the relevance of science and science issues in the public domain. With my triple science focus group, I put the emphasis in the lessons on Physics.		10.	long term.	
Mixed gender, 11-19, 1393 pupils, specialist technology. %SEN above average. %FSM well below average. The school population is largely White British and very few pupils come from minority ethnic backgrounds.	How to increase the numbers of AS/A2 pupils taking Physics, particularly girls? How to Increase the awareness of careers in Physics?	Careers and Progression a) A new Physics display was put in a prominent corridor, using Institute of Physics posters, showing girls doing sound engineering, designing computer games, doing environmental and medical work. This display illustrates the capacity for earning good salaries and shows the wide variety of careers available. b) The above display was prepared as a powerpoint presentation and shown to yr10 and yr11 triple science groups. c) The above resources were used to improve the Physics display at the yr 11 opportunity evening, held on 2nd Dec 2010. A lady Physics teacher was present and a girl from the current yr12. d) The profile of Physics in the lower school was raised by holding: A Starchaser rocket day for yr 9, involving a 5metre rocket on the school site, together with rocket building and firing. A Musical Physics project for yr 8. Pupils were given physics experiments involving music/instruments and asked to demonstrate them to yr6 pupils. An Astronomy club for yr7. e) To link Science to careers, employers were invited into school in July, to talk to yr10 pupils. These involved the areas of Solar power, Engineering, Energy, Medical, Recycling , Robotics, CCTV and the RAF. f) A previous A level Physics pupil, who achieved a 2.1 degree at Warwick University, and has just secured a job in the Nuclear industry, was invited in to talk to prospective Physics pupils.	In September 2010 the AS Physics group comprised of 18 pupils including 7 girls, compared to 2 girls out of 15 in 2009 and no girls out of 12 the year before. Also, from the opportunity evening held in December 2010, a total of 22 pupils including 10 girls signed up for AS Physics. From the Starchaser survey 37% of yr9 pupils surveyed said they would now consider Space/Physics as a career option. From the Science at work day survey 62% of yr10 pupils surveyed said that they now understood better, the need for a Science qualification to secure a good job. From the Musical Physics survey all of the 25, yr 8 pupils who took part said that it greatly increased their interest in Science/Physics.		The changes made as a result of this work are sustainable as far as finances will allow.	We plan to continue the initiatives started and also as a result of this work it has revealed a new area of interest with regard to Physics equipment. Much of the current equipment in school is old and underused, many of the non Physics specialists are not aware of how to use it. Also, it has been recognised that there is new, sometimes cheap, items available that could enhance Physics teaching, particularly at KS4. We hope to focus on this in the future.

Mixed gender, 11-16, 959 pupils, specialist humanities, serving pupils from relatively advantaged social circumstances. %FSM very low. Most pupils are White British. %SEN broadly average.	Do pupils see the relevance of physics to career/further study choices? Why do pupils see physics as a ‘hard’ subject? Why is uptake falling at FE/HE? What information do pupils get on careers prior to GCSE choices? (are Connexions doing the job early enough?)	Physics notice board bought and put up to display info on careers / from IOP etc. Looking into getting an ambassador in – not yet done. Past pupils spoke to pupils/parents at Y9 choices evening. Science Live visit to Leeds (ahead of final choices). Part subsidised by STEM funding/ARPP funding? Early start KS4 teaching (Jan 2011) to enable more pupils to take separate sciences.	Excellent feedback from parents at feedback evening. Many parents seeking 3 sciences for their child. Many pupils are talking and asking about taking separate sciences. Verbal feedback from pupils on the Science Live event was very positive (41 ‘higher’ pupils in this)		It is hoped the change will be sustained as there is likely to be a permanent change to the curriculum and arrangements in science. Physics noticeboard will be updated regularly and will include Alumni section. Links with 6th form colleges are already well established and will continue. STEM funding will continue to be used appropriately to support events.	Tracking of pupils will continue. As a school there will be a greater emphasis on separate sciences.

Teaching and Learning Interventions with a little impact

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Independent girls’ school, 11-16, 475 pupils	Does enabling pupils to feed back ideas through means other than ‘hands up’ give pupils more confidence in Physics lessons learning about GCSE electricity in year 9/10?	Change method of getting responses from class (avoid using ‘hands up’ as much as possible).	Enjoyed the random name generator and group work although these both have their drawbacks as well e.g. differentiation.	Girls still find topic very hard and not interested despite my best efforts! They did appreciate chance to do things differently but some felt frustrated by not being able to answer a question when they did know the answer.	I will incorporate some of the ideas into all my lessons in the future so change should have small impact over long period of time.	
Girls’ school, 11-18, 987 pupils, specialist engineering and languages; Gifted and Talented Lead School. %FSM and %SEN well below average. % from minority ethnic backgrounds is above average; %EAL average.	Can using everyday examples an anecdotes in Physics lessons improve attitudes to Physics?	For each lesson, an anecdote or everyday example was included.	Pupils seem to find Physics slightly more interesting. This was observed in their attitude in lessons and their own declarations in the questionnaires.	There didn’t seem to be a significant difference in the number of pupils that were definitely intending to take Physics A level.	The anecdotes and everyday application will be built into the new scheme of work from sept 2011 and so other yr10/11 pupils will have the same experiences in future years.	I intend to continue to keep up to date with current Physics issues and continue to put anecdotes and applications into lessons regularly. I would like to look at the impact of looking at Physics related amusing youtube clips to see how the pupils enjoy them.
Mixed gender, 11-18, 1013	**What are pupils’ current**	**My intended intervention strategy was**	**Interest in physics: pre- 243% Post –**	**Some pupils still didn’t**	**Working on**	**My main goal is to wider**

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
pupils, specialist technology; %FSM well below average although the school's catchment area has a wide socio-economic mix and has parts with significant deprivation. Few pupils come from minority ethnic groups; %EAL low. %SEN below average.	**perceptions of physics within my school? Will alternative approaches to learning enhance their perceptions? Will increased understanding of what physics is improve attainment in the subject?**	**to try new teaching and learning methods. This was carried out with a year 9 szet 2 class over one unit of the year 9 scheme of work, Pressure and Moments. I planned lessons which had a clear focus on collaborative and active learning activities.**	**37% Possibility of take-up Post-16: pre – 20% Post 52% Not enough time for discussion: Pre 48% Post 24% Not enough thinking time: Pre 48% Post 28% Gender bias appeared not to be an issue 80% (72%)**	**have a clear idea about what physics is Pupils did not register links made to careers in the lessons (only 15% indicated they had been spoken to about careers in physics) Numbers finding the concept of physics difficult and not interesting remained the same**	**embedding physics careers into schemes of work Extra-curricular opportunities for physics are scheduled. The change to my teaching practice will continue and hopefully others in the department will take in board the messages from the research.**	**particiupation in extra-curricular physics activities. Having a clearer focus group who can have physics marketed to them in a way that will engage and excite them about the project.**

Careers and Guidance Interventions with a little impact

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Mixed gender, 11-18, 1815 pupils, specialist technology; 30%from a range of minority ethnic backgrounds, with the great majority being fluent in English. %SEN below average.	Did the improved knowledge of possible career paths and vocations have an impact on the options pupils take at GCSE (in Y9) and A level (in Y11). What types of activity have an impact and do any particular areas of careers have a positive impact on the pupils/pupils choices.	A small group of year 9 pupils were taken on two trips out of school. One was a careers event targeting STEM subjects, hosted by UK power networks. The other was a trip to Tilbury power station. Both had careers advice where one was specific throughout and the other was part of the workings of the power plant. Y11 had talks from STEM ambassadors giving details on their work in engineering and how they got to where they are. As this had happened with the previous Y11 (current Y12) I also question them on the retrospective view of this type of talk in Y11.	Of the pupils in Y12 reflecting on the previous year some were unsure as to whether or not they had a 20 min talk at the start of a lesson. However, the ones who remembered the talks though they had improved their understanding and helped with the options.	The Y9 and Y11 had very mixed views on this affecting their options. The majority thought it did not have much of an impact however, a small number did think this has given them and idea of what taking physics (or more STEM subjects) can do for them in the long run.	With intervention in Y9 and then again in Y10 this should be something that can be targeting pupils over a few years and with a constant reinforcement may highlight to pupils possible career paths. However, it is clear that the KS3 pupils make up their minds very early as to what subjects they like and what they don't. This with a narrow knowledge of careers available to them means some are switched off science as they don't want to be a "scientist". While the change is very small an increase of 4 As level physics pupils would be 10% increase.	I will continue to try to get more careers event into school and will aim to involve Y10 more as this is when they will start to think of possible A levels. I will also aim to run a further questionnaire with the Y12 when they are doing their UCAS applications and see if this has any impact on their degree choices.

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
					The school has just started a 3 year KS4, starting in Y9 and so none of them have to opt for triple science as 90% of the year group are doing this and 10% doing Btec. This is why the focus has moved slightly with Y9 from physics (triple science) to more STEM subjects.	
Mixed gender, 11-18, 847 pupils, B&E specialist; majority of White British background, growing number joining the school from various minority ethnic backgrounds who speak a variety of languages. %EAL below the national average; %SEN slightly above average. [this is a school with an exceptionally high number of pupils on FSM]	**Do pupils have an interest in physics? Do pupils have physics based career aspirations? (If so) Do pupils understand what is involved in reaching these physics based aspirations?**	**Intervention involved the implementation of physics based starters within the classroom. These starters were linked to SAT based lessons in year 9 classes and related the current physics topic to a career progression route. The aim was to contextualise physics topics and link the topic to a career based application. Additionally I introduced informal "question sessions" where pupils had the opportunity to ask questions relating to jobs in physics.**	**Following the implementation of career linked physics starters, a greater proportion of pupils expressed an increase in interest in physics (10%). Although a small difference, there appeared to be a greater awareness of career options via pupils' informal questioning.**	**When further questioned, many pupils expressed the view that they had not previously completely understood what physics involved. An area which was exposed as part of this initial research, was that whilst many of the pupils appeared to take an interest in the physics opportunities available to them, through the career starters, many were confused about how to reach these careers. Some pupils expressed confusion about what could be studied at college or University, and what physics should be studied alongside.**	**I believe that the strategies are sustainable, but requires support of all department staff. This is difficult to apply consistently before year 10, when the syllabus becomes more defined and exam driven. The informal aspects of the research appear to be much more sustainable but require a sustained change of approach to teaching, and consistent contextualisation and informal questioning.**	**My next area of research will be paths into physics; identifying pupils' level of understanding of how to become involved in physics based careers, and measuring whether this can be changed through teaching. There is a potential to investigate and compare different year groups based on the same criteria. It could be interesting to investigate whether there are differences in aspirations across different year groups. Also I could investigate how pupils of different ages respond to career based contextualisation. I hope that for the future, there will be continued development of question and answer sessions.**

Combined Strand Interventions with a little impact

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Mixed gender; 11-19, 1785 pupils, specialist performing arts; serves the local community and large rural hinterland. The vast majority of pupils are White British. %SEN above the national average and %FSM a little below average.	Does the deliberate and planned exposure of pupils to "Big Picture" Physics* (exciting inspiring curiosity-provoking material) stimulate them to 'want more'? *even when this goes beyond the curriculum – in fact 'especially when' really.	Ethos and Learning & Teaching Deliberate, regular (targeted every lesson, hit most), planned relation of classroom learning to "Big Picture" Physics, to go alongside (not replace!) occasional, and spontaneous moments. e.g. Big Bang, relativity, 'stories' of scientists, quantum, cryogenics, etc Because (hypothesis) this is what actually engages and interests pupils and makes them likely to wish to pursue the subject.	Still measuring impact – but not as much as hoped by evidence analysed so far. Assessment grades show small (negligible I think) impact. Attitudinal impact not analysed yet Classroom – I continue to use my strategy with all groups I teach.	Department/school – no impact as yet, if I find some positive results in attitudes I will encourage other Physics teachers to follow suit … Unexpected – not really – obviously I wasn't hoping for a null result with the assessment grades, but it doesn't count as a surprise!	In terms of my own personal teaching I think its fairly permanent. I expect I will develop/evolve it during my career, and encourage others to take the same view.	I would love I would love to build a bank of video-clips from the great TV we have had recently (Brian Cox etc) which were exactly the kind of thing I was trying to do. to build a bank of video-clips from the great TV we have had recently (Brian Cox etc) which were exactly the kind of thing I was trying to do.

Ethos Interventions with a little impact

School background	Research Questions	Intervention	Positive outcomes	Limitations	Sustainability	Next steps
Mixed gender, 11-16, 1289 pupils, specialist technology and applied learning; % minority ethnic groups and %EAL broadly average. %SEN and %FSM below the national average.	How can the profile of Physics be raised within the school?	Specialist revision intervention for KS4 examination classes. Adoption of distinct identification of POS units within Core and Triple Science	Improved physics module results at KS4. Pupils being aware of "physics" rather than "science".		Difficult to assess until exam results have been analysed.	

Appendix 2

Action Research for Physics Programme – Reporting Template

This template is designed to help you report your results from your Action Research project. Please complete a draft in advance of the final project workshop and upload it to your region's area of the Science Learning Centre portal. There will be a session during the workshop to reflect on and discuss the content of the report.

Indicative lengths have been provided for each of the responses in order to give you an idea of how much detail to include for each question.

Your name ………………………………………………………………

School ………………………………………………………………

SLC region ………………………………………………………………

1. **Research question/s**: *What broad question/s did you use to guide your research?* [up to 3 sentences]

2. **Action Research cluster**: *Which of the six practice areas did your project address?* [please mark your one MAIN area with an 'X']

Careers and guidance	
Progression routes	
Ethos	
Learning and teaching	
Classroom management	
Workforce	

3. **Intervention**: *What 'action' did you take as part of the Action Research project, i.e. what changed in your classroom, department or school?* [4 – 6 lines]

4. **Your Research**: *What methods did you use to answer your research question/s?* [4 – 6 lines]

5. **Background**: *What are the concerns that prompted your intervention? What was the original situation in your classroom, department or school prior to your intervention? Why did you choose to run that particular intervention?* [4 – 6 lines]

6. **Status**: *How far along are you in the process associated with your intervention? Is it completed or ongoing? Over what timescale do you envisage seeing results?* [4 – 6 lines]

7. **Impact**: *How much of an impact do you think your intervention had or will have?*
[Place an 'X' in the box to the left of the answer you wish to select]

	No change		A little change		Some change		Major change

8. **Outcomes**: *What was the impact of your intervention? What evidence do you have for the stated impact? (<u>Include</u> how it has affected the attitudes of learners.) What has changed or is changing in your classroom, department or school as a result of the intervention? Was there anything unexpected that occurred?* [8 – 12 lines]

9. **Sustainability**: *How long will the change that has occurred (or is occurring) likely to last? Is the change relatively short-term or sustainable over a longer period?* [4 – 6 lines]

10. **Learning**: *What have you learned from your Action Research? Is there anything you would do differently in the future, both in terms of your teaching practice and how you ran the Action Research project?* [6 – 10 lines]

11. **Dissemination**: *How have you (or how are you going to) share/d the learning from the project? With whom will you share the learning? This could be within your school or a wider arena – for example staff meetings, ASE regional conferences etc.* [4 – 6 lines]

12. **Next Steps**: *How do you plan to progress when your Action Research project is completed? Did any new areas of interest emerge as a result of your project that you would now like to investigate further?* [4 – 6 lines]

13. **Reflection**: *Do you have any comments on how the overall 'Action Research for Physics Programme' has been run? Were any aspects particularly useful or can you identify specific ways to improve a similar project in the future?* [4 – 6 lines]

Appendix 3

Questionnaire and interview questions

<u>Appendix 3.1 Teacher questionnaire 1 (Pre-intervention)</u>

Evaluation of Action Research for Physics Project

1. Your background

Question 1.

Your name

....

Question 2.

Male/Female (please circle)

Question 3.

Your School/College

....

Question 4.

Which Science Learning Centre are you working with?

....

Question 5.

What is your science subject background? Please tick:

☐ Biology
☐ Chemistry
☐ Engineering
☐ Environmental Science
☐ Geology
☐ Physics

☐ Science (my whole degree)
☐ Science (part of my degree)
☐ Other, please specify:

....

Question 6.

What's your highest physics-related qualification?

☐ GCSE/O level in Science
☐ GCSE/O level in Physics
☐ AS level in Physics
☐ A level in Physics
☐ Bachelors degree in physics-related subject
☐ Masters degree in physics-related subject
☐ PhD/EdD in physics-related subject
☐ Other, please specify:

....

Question 7.

How long have you been teaching science?

☐ Less than 1 year
☐ 1-5 years
☐ 6-10 years
☐ More than 10 years

Question 8.

How much action research have you done before?

☐ None

☐ A little

☐ A lot

Question 9.

How much on-line technology have you previously used, for support and for sharing ideas with other teachers?

- ☐ None
- ☐ A little
- ☐ A lot

2. Your views

Question 1.

What are your main concerns about teaching physics?

....

....

....

....

....

....

Question 2.

What needs changing in your classes to encourage more pupils to take physics at post 16? (particularly - but not only - for girls, and gifted & talented pupils)

....

....

....

....

....

....

Question 3.

In your physics lessons, how often do you:

	Often	Sometimes	Rarely
a. encourage dialogue between teacher and pupil?	☐	☐	☐
b. encourage dialogue between pupil and pupil?	☐	☐	☐
c. differentiate work for able, gifted and talented pupils?	☐	☐	☐

d. differentiate work for girls and boys?	☐	☐	☐
e. use gender-neutral illustrations and examples?	☐	☐	☐
f. use non-technical language and analogies where possible?	☐	☐	☐
g. link physics with careers?	☐	☐	☐
h. link physics topics together?	☐	☐	☐
i. link physics to other subjects?	☐	☐	☐
j. link physics to the everyday lives of the pupils?	☐	☐	☐
k. link physics to global/social challenges?	☐	☐	☐

THANK YOU VERY MUCH

Appendix 3.2 Final Teacher Questionnaire

(Teacher questionnaire 2)

Evaluation of Action Research for Physics Project

Thank you for filling in this questionnaire. It should not take more than 15 minutes to complete. All your responses will be treated anonymously and confidentially, and no comments will be attributed to named individuals or schools.

Section 1. About you

1. **Your name:**

2. **Your school:**

3. **Which Science Learning Centre are you working with?**

4. **Please give the title of, and briefly outline, your physics action research intervention.**

5. **In which area of practice is your action research?**

- ☐ Learning and teaching
- ☐ Classroom Management
- ☐ Careers
- ☐ Progression
- ☐ Workforce
- ☐ Culture and ethos
- ☐ Other or a combination of the above; please specify: ....

....

Section 2. Your views/experiences

6. **What is your general feeling about taking part in the Action Research for Physics Programme?**

- ☐ Very positive
- ☐ Positive
- ☐ Neutral
- ☐ Negative
- ☐ Very negative

7. **How effective do you feel your participation in the Action Research for Physics Programme has been in increasing your students' engagement with physics?**

- ☐ Very effective
- ☐ Quite effective
- ☐ Effective nor ineffective
- ☐ Not very effective
- ☐ Not at all effective
- ☐ Not sure

8. **How have the following changed for you since you started the programme?**

	increased	remained the same	decreased
Your interest in teaching physics?	☐	☐	☐
Your motivation/enthusiasm to teach physics?	☐	☐	☐
Your confidence in teaching physics?	☐	☐	☐

9. **How has your *confidence* in the following areas changed?**

	increased	remained the same	decreased
Your confidence in your physics subject knowledge			
Your confidence in your ability to answer students' physics questions			
Your confidence in your ability to get students engaged in physics			
Your confidence in your ability to get girls engaged in physics			
Your confidence in your ability to make physics relevant			
Your confidence in your ability to boost students' confidence in physics			
Your confidence in your ability to boost girls' confidence in physics			
Your confidence in your ability to sufficiently challenge able students in physics			
Your confidence in your ability to increase students' awareness of careers/futures in physics			
Your confidence in your ability to maximise physics learning interactions between boys and girls			
Your confidence in your ability to acquire interesting resources			

Your confidence in your ability to make the most of resources	☐	☐	☐
Your confidence in being able to make abstract physics more ‘visible’ for students	☐	☐	☐
Your confidence in teaching “cutting edge” physics	☐	☐	☐
Your confidence in teaching “wow!” physics	☐	☐	☐

10. How much do you feel you have learnt about action research through the programme?

☐ A lot

☐ Quite a lot

☐ A little

☐ Not very much

☐ Nothing at all

11. How useful do you find action research in terms of improving classroom practice?

☐ Very useful

☐ Quite useful

☐ Not very useful

☐ Not at all useful

Please explain:

Section 3. Effects of the programme on teaching physics

12. How often do you in your physics lessons:

	Often	Sometimes	Rarely
Encourage dialogue between teacher and student?	☐	☐	☐
Encourage dialogue between student and student?	☐	☐	☐
Differentiate work for able, gifted and talented students?	☐	☐	☐
Differentiate work for girls and boys?	☐	☐	☐
Use gender-neutral illustrations and examples?	☐	☐	☐
Use non-technical language and analogies where possible?	☐	☐	☐
Link physics with careers?	☐	☐	☐
Link physics topics together?	☐	☐	☐
Link physics to other subjects?	☐	☐	☐
Link physics to the everyday lives of the students?	☐	☐	☐
Link physics to global/social challenges?	☐	☐	☐

13. How much use do you make of online technology for support and for sharing ideas with other teachers?

- ☐ A lot
- ☐ A little
- ☐ None

14. What has changed in your practice as a result of your action research? (I.e. what did you find worked or didn't work through your action research that has resulted in you changing your practice accordingly?)

15. As a result of the programme <u>as a whole</u>, have you made any changes to your physics classes?

- ☐ Yes
- ☐ No

Please outline briefly:

16. **Have you made any changes to your schemes of work as a result of participating in the programme?**

- ☐ Yes
- ☐ No

Please specify briefly:

17. **Have you made any changes to:**

	I have increased it	I have kept it the same	I have decreased it
The amount of reflection time in your classes?	☐	☐	☐
The amount of discussion time in your classes?	☐	☐	☐

18. **If the project has changed the way you teach physics, how has this affected your *colleagues*? Please tick all that apply:**

- ☐ My colleagues are not very interested in my new approach to teaching physics
- ☐ My colleagues are interested in my new approach to teaching physics but are not adopting these in their own lessons
- ☐ My colleagues are interested in my new approach to teaching physics and are adopting these in their own lessons
- ☐ My Head of Department is using changes in the way I teach physics to help improve the teaching of physics throughout the department
- ☐ Changes in the way I teach physics are/will be discussed/implemented on a wider school level
- ☐ Changes in the way I teach physics are/will be discussed with/implemented in schools we work with
- ☐ Other, please state: ....

....

Section 4. Other

19. **Are there any other important findings from your own action research intervention that you would like to mention?**

20. **Do you have any remaining concerns about teaching physics?**

21. **Any other comments:**

Thank you very much

Appendix 3.3 Pupil Questionnaire 1 *(pre-intervention)*

Physics Action Research Project (student questionnaire 1)

Students' Feelings about Physics

THIS IS NOT A TEST!

Thank you for filling in this questionnaire.
The results will remain anonymous, so please just say what you feel.

1. Your school:

2.

Female	Male

(please circle)

3. How difficult do you find physics? (please circle one)

Very difficult	Quite difficult	Quite easy	Very easy

4. How interested in physics are you? (please circle one)

Very interested	Quite interested	Not very interested	Not at all interested

5. What things in physics particularly interest you?

6. What things in physics don't particularly interest you?

7. What relevance does physics have to your everyday life? (list 3 things if you can)

1.

2.

3.

PLEASE TURN OVER

8. How likely are you to study physics <u>after</u> your GCSEs? (please circle one)

Definitely	Very likely	Maybe	Not likely	Definitely not

9. What kind of career would you eventually like? (if you don't know yet, please say so)

10. Has anyone ever talked to you about careers in physics? YES/NO

If YES, who? (please circle all that apply)

Parent	Science teacher	Form tutor	Careers advisor	Other? (please say who)

11. How difficult do you find the words/terms used in physics lessons? (please circle)

Very difficult	Quite difficult	Quite easy	Very easy

12. Do you feel that your physics lessons are aimed:

more at boys?	more at girls?	the same at girls and boys?

(please circle one)

13. In your physics lessons, how often is physics linked to:

a) other subjects?

often	sometimes	rarely

b) your everyday life?

often	sometimes	rarely

c) worldwide issues?

often	sometimes	rarely

14. How much time is there in physics lessons for discussion? (please circle one)

Too much	About the right amount	Not enough

15. How much time is there in physics lessons to think things through properly? (please circle one)

Too much	About the right amount	Not enough

THANK YOU VERY MUCH

Appendix 3.4 Pupil Questionnaire 2 *(mid-intervention)*

Pupils' Feelings about Physics

THIS IS NOT A TEST!

Thank you for filling in this questionnaire.
The results will remain anonymous, so please just say what you feel.

We know that you have answered most of these questions before, but we are very interested to find out how you feel NOW.

1. Your school:

Female	Male

(please circle) 2.

3. How difficult do you find physics? (please circle one)

Very difficult	Quite difficult	Quite easy	Very easy

4. Do you find physics more, the same, or less difficult than before?

More difficult	The same	Less difficult

5. How interested in physics are you? (please circle one)

Very interested	Quite interested	Not very interested	Not at all interested

6. Do you find physics more, the same, or less interesting than before?

More interesting	The same	Less interesting

7. What things in physics particularly interest you?

8. What things in physics don't particularly interest you?

PLEASE TURN OVER

9. What relevance does physics have to your everyday life? List 3 things if you can:

1. 2. 3.

10. How likely are you to study physics <u>after</u> your GCSEs? (please circle one)

Definitely	Very likely	Maybe	Not likely	Definitely not

11. What kind of career would you eventually like? (if you don't know yet, please say so)

12. Has anyone ever talked to you about careers in physics? YES/NO

If YES, who? (please circle all that apply)

Parent	Science teacher	Form tutor	Careers advisor	Other? (please say who)

13. How difficult do you find the words/terms used in physics lessons? (please circle)

Very difficult	Quite difficult	Quite easy	Very easy

14. Do you feel that your physics lessons are aimed:

more at boys?	more at girls?	the same at girls and boys?

(please circle one)

15. In your physics lessons, how often is physics linked to:

a) other subjects?

often	sometimes	rarely

b) your everyday life?

often	sometimes	rarely

c) worldwide issues?

often	sometimes	rarely

16. How much time is there in physics lessons for discussion? (please circle one)

Too much	About the right amount	Not enough

17. How much time is there in physics lessons to think things through properly?

(please circle one)

Too much	About the right amount	Not enough

THANK YOU VERY MUCH!

Appendix 3.5 Pupil Questionnaire 3 *(post-intervention)*

Pupils' Feelings about Physics

THIS IS NOT A TEST!

Thank you for filling in this questionnaire.
Your answers will remain anonymous, so please just say what you feel.

We know that you have answered most of these questions before, but we are very interested to find out how you feel NOW.

1. Your school:

Female	Male	(please circle)

2.

3. How difficult do you find physics? (please circle one)

Very difficult	Quite difficult	Quite easy	Very easy

4. Do you find physics more, the same, or less difficult than before?

More difficult	The same	Less difficult

5. How interested in physics are you? (please circle one)

Very interested	Quite interested	Not very interested	Not at all interested

6. Do you find physics more, the same, or less interesting than before?

More interesting	The same	Less interesting

7. What things in physics particularly interest you?

8. Is there anything you have found particularly interesting in physics over the last couple of months?

9. What things in physics don't particularly interest you?

PLEASE TURN OVER

10. What relevance does physics have to your everyday life? List 3 things if you can:

1. 2. 3.

11. How likely are you to study physics after your GCSEs? (please circle one)

Definitely	Very likely	Maybe	Not likely	Definitely not

12. What kind of career would you eventually like? (if you don't know yet, please say so)

13. Has anyone ever talked to you about careers in physics? YES/NO

If YES, who? (please circle all that apply)

Parent	Science teacher	Form tutor	Careers advisor	Other? (please say who)

14. How difficult do you find the words/terms used in physics lessons? (please circle)

Very difficult	Quite difficult	Quite easy	Very easy

15. Do you feel that your physics lessons are aimed:

more at boys?	more at girls?	the same at girls and boys?

(please circle one)

16. In your physics lessons, how often is physics linked to:

a) other subjects?	often	sometimes	rarely
b) your everyday life?	often	sometimes	rarely
c) worldwide issues?	often	sometimes	rarely

17. How much time is there in physics lessons for discussion? (please circle one)

Too much	About the right amount	Not enough

18. How much time is there in physics lessons to think things through properly?

(please circle one)

Too much	About the right amount	Not enough

19. Any other comments about your physics lessons, particularly over the last 2-3 months?

Appendix 3.6 Pupil Questionnaire (year above target group - the control group)

Pupils' Feelings about Physics

THIS IS NOT A TEST!

Thank you for filling in this questionnaire.
The results will remain anonymous, so please just say what you feel.

1. Your school:

2.

Female	Male

(please circle)

3. How difficult do you find physics? (please circle one)

Very difficult	Quite difficult	Quite easy	Very easy

4. How interested in physics are you? (please circle one)

Very interested	Quite interested	Not very interested	Not at all interested

5. What things in physics particularly interest you?

6. What things in physics don't particularly interest you?

7. What relevance does physics have to your everyday life? (list 3 things if you can)

1.

2.

3.

PLEASE TURN OVER

8. How likely are you to study physics <u>after</u> your GCSEs? (please circle one)

Definitely	Very likely	Maybe	Not likely	Definitely not

9. What kind of career would you eventually like? (if you don't know yet, please say so)

10. Has anyone ever talked to you about careers in physics? YES/NO

If YES, who? (please circle all that apply)

Parent	Science teacher	Form tutor	Careers advisor	Other? (please say who)

11. How difficult do you find the words/terms used in physics lessons? (please circle)

Very difficult	Quite difficult	Quite easy	Very easy

12. Do you feel that your physics lessons are aimed:

more at boys?	more at girls?	the same at girls and boys?

(please circle one)

13. In your physics lessons, how often is physics linked to:

a) other subjects?

often	sometimes	rarely

b) your everyday life?

often	sometimes	rarely

c) worldwide issues?

often	sometimes	rarely

14. How much time is there in physics lessons for discussion? (please circle one)

Too much	About the right amount	Not enough

15. How much time is there in physics lessons to think things through properly?

(please circle one)

Too much	About the right amount	Not enough

THANK YOU VERY MUCH

Appendix 3.7 Senior Managers' Questionnaire

Action Research for Physics Programme - Views of Teachers' CPD Managers

Thank you for spending time to fill in this questionnaire. It should take no longer than 15 minutes to complete. Your views will remain anonymous and confidential and no responses will be attributed to individuals or schools; therefore we hope that you can be as frank as possible.

1. Your school:

2. What is your position in the school?

3. To what extent did the following factors play a role in the teacher's participation in the Action Research for Physics Programme?

	Very strong factor	Quite a strong factor	Not a very strong factor	Not at all a factor	Don't know
Pupil needs	☐	☐	☐	☐	☐
Teacher development	☐	☐	☐	☐	☐
Estimated impact on department	☐	☐	☐	☐	☐
Estimated impact on wider school level	☐	☐	☐	☐	☐
High regard of the course	☐	☐	☐	☐	☐
High regard of the provider	☐	☐	☐	☐	☐
IMPACT award attached to the course	☐	☐	☐	☐	☐
Other, please state:	☐	☐	☐	☐	☐

4. Please expand and comment on your answers to question 3 if necessary:

5. How aware were you of the course content before the course started?

- [ ] Very aware
- [ ] Quite aware
- [ ] Not very aware
- [ ] Not at all aware
- [ ]

Not very aware

6. How aware/informed are you about the course content at present?

- [ ] Very aware/informed
- [ ] Quite aware/informed
- [ ] Not very aware/informed
- [ ] Not at all aware/informed

7. What is your understanding of the nature of the teacher's classroom intervention and the impact it has had?

8. Please indicate the extent to which you feel the teacher's participation in the course has impacted on:

	A lot	Quite a lot	A reasonable amount	Not very much	Nothing at all	Don't know
Pupil learning	☐	☐	☐	☐	☐	☐
Pupil performance	☐	☐	☐	☐	☐	☐
Pupil attitudes to physics	☐	☐	☐	☐	☐	☐
Pupil post-16 uptake of physics	☐	☐	☐	☐	☐	☐
The teacher's effectiveness as a teacher	☐	☐	☐	☐	☐	☐
The teacher's attitude to teaching physics	☐	☐	☐	☐	☐	☐
The teacher's confidence levels in teaching physics	☐	☐	☐	☐	☐	☐
Other teachers in the department	☐	☐	☐	☐	☐	☐
The school as a whole	☐	☐	☐	☐	☐	☐
Other, please state:	☐	☐	☐	☐	☐	☐

9. Please elaborate on your answers to question 8 if you wish:

10. What is your view on the usefulness of action research for classroom improvement?

☐ Very useful

☐ Quite useful

☐ Not very useful

☐ Not at all useful

11. How useful do you feel the teacher's participation in the course has been on the whole?

- ☐ Very useful
- ☐ Quite useful
- ☐ Not very useful
- ☐ Not at all useful

12. Do you have any plans about using your teacher's findings in future staff development?

Yes	No	Maybe
☐	☐	☐

13. Please elaborate on your answer to Question 12:

14. Would you send other teachers on the course in the future?

Yes	No	Maybe
☐	☐	☐

15. Please explain your answer to question 14 if necessary:

16. Would you recommend this course to other CPD managers?

Yes	No
☐	☐

17. Any other comments [textbox]

Many thanks for completing this questionnaire

Appendix 4 Questions used in focus group meetings and interviews

Appendix 4.1

Focus Group Questions - Pupils' Feelings about Physics Pre-Intervention

1. How interested are you in physics? What do you find interesting, what do you find less interesting about physics? (If applicable: What would make it more interesting for you?)

2. How difficult do you find physics? Why is this? (if applicable: What could be done about it?)

3. How difficult do you find the words/terms used in physics lessons? Please explain.

4. In what way do you think physics is relevant to your everyday life?

5. In your physics lessons, how often is physics linked to:
    a) other subjects?; b) your everyday life?; c) worldwide issues?
How do you feel about this? Should it be more/less in any of these areas? Are there any of these areas (or another one) in which you are more interested?

6. How likely are you to study physics <u>after</u> your GCSEs? What are the reasons for this?

7. Are you interested in a career involving physics (such as engineering, medical professions, …) ? What (if any) careers involving physics would you be interested in? Why (not)?

8. Has anyone ever talked to you about careers in physics? In what way? Was it helpful? How did this talk affect your interest in a career involving physics? Why?

9. Do you feel that your physics lessons are aimed: more at boys/more at girls/the same at girls and boys? How/why does this happen? What is it that makes it more for one of these groups / the same for both groups?

10. Do you feel that physics or a career involving physics generally is more for girls/more for boys/no difference? Why?

11. How much time is there in physics lessons for discussion? (please explain)
Do you find discussion helpful in physics? In what way?

12. How much time is there in physics lessons to think things through properly?
Is that important to you? How/why?

13. Any other comments about physics / physics lessons?

Appendix 4.2

Focus Group Questions - Pupils' Feelings about Physics Post-Intervention

1. How interested are you in physics? What do you find interesting, what do you find less interesting about physics? Has your interest changed over the last couple of months? If so, how?

2. How difficult do you find physics? Why is this? Has this changed over the last couple of months? If so, how?

3. How difficult do you find the words/terms used in physics lessons?

4. In what way do you think physics is relevant to your everyday life?

5. In your physics lessons, how often is physics linked to:

   a) other subjects?; b) your everyday life?; c) worldwide issues?

How do you feel about this? Should it be more/less in any of these areas? Are there any of these areas (or another one) in which you are more interested?

6. How likely are you to study physics <u>after</u> your GCSEs? What are the reasons for this? Have there been any changes in this over the last couple of months? If so, what has caused these?

7. Are you interested in a career involving physics (such as engineering, medical professions, …) ? What (if any) careers involving physics would you be interested in? Why (not)? Have there been any changes in this over the last couple of months? If so, what has caused these?

8. Has anyone ever talked to you about careers in physics? In what way? Have there been any changes in this over the last couple of months?

9. Do you feel that your physics lessons are aimed: more at boys/more at girls/the same at girls and boys? Have there been any changes in this over the last couple of months? If so, what has caused these?

10. Do you feel that physics or a career involving physics generally is more for girls/more for boys/no difference? Have there been any changes in this over the last couple of months? If so, what has caused these?

11. How much time is there in physics lessons for discussion? Have there been any changes in this over the last couple of months? If so, what has caused these?

12. How much time is there in physics lessons to think things through properly?
Have there been any changes in this over the last couple of months? If so, what has caused these?

13. Any other comments about physics / physics lessons, particularly during the last couple of months?

Appendix 4.3

ARPP questions to teachers at final CPD day

- What did you find most useful about the course?

- What did you find least useful about the course?

- What did you feel was the major effect of your action research intervention on
  a. your students (engagement? progression?)
  b. your teaching (action research?)

- What effect has the ARPP programme had on
  a. You
  b. Your department?

- Did you notice any benefits for girls/G&T?

- Have concerns about your teaching of physics expressed at the beginning of the programme been 'dealt with'? Do you have any continuing concerns? (for instance confidence?)

- Have you increased the amount of time you spend on discussion/reflection time?

- How useful do you think action research is for improving classroom practice?

- From looking at your students now, do you think they will be more likely to progress to post-16 physics? If so, what do you think are reasons for this?

- Do you have any plans/ideas about tracking these students until they make their post-16 choices?

Appendix 4.4

Course Tutor Interview Questions

1. How useful do you generally feel the course seems to have been for participants?

2. What do you feel worked well/was successful in the course? (in terms of the set-up, the content of the sessions, the action research element for delegates; the timing of the sessions and the space in between)

3. What worked less well and could be improved?

4. How do you feel delegates have engaged with their action research projects? What impact do you think the training has had on teaching and learning?

5. Have delegates learned about action research in the way/extent you were hoping they would?

6. Have you come across any particularly interesting or surprising results from delegates as to what they found works well in the classroom?

7. Have you noticed any changes in delegates' approaches/attitudes to teaching physics, for example in their confidence/enthusiasm levels in teaching physics? – this could be from their participation in the CPD sessions or from lesson observations for example.

8. Are there any aspects of the course that you feel received too much or too little attention, either in the CPD sessions or in delegates' action research and their reported learning?

9. How would you teach the course in the future, what would you change, what would you keep the same?

10. Have you developed ideas for new courses/learning from this course?

11. Any other comments?

Appendix 5.

Overview of answers to open questions

Appendix 5.1

Pupil Questionnaire 3: Any Other Comments about your physics lessons?

- a bit dull...
- a lot of coursework
- All good enough time to understand + work through work
- always try to find links to the physics we're learning to everyday life
- amusing and more attractive
- amusing and more interactive, thinking time not controlled enough
- become more enjoyable than before
- been busy because of exams so spent them doing revision
- been fun
- better girls only
- bit boring!
- boring (9x)
- boring, difficult
- boring, difficult, bored to tears
- boring, doesn't grab my attention at all. prefer biology
- boring, need to do more practicals
- can't concentrate properly because no-one stops talking, but we are learning new things
- confusing but alright
- could be more practicals
- could be more practicals
- demos always fail. speeding through topics, not thorough enough
- doing more practicals
- don't learn much
- dull, uninspiring, lazy teaching
- enjoy practicals
- enjoyable and constructive progress
- enjoyable and productive lesson
- enjoyed them
- everyone likes teacher
- expand on our understanding of the jobs involved
- experiments outside
- experiments outside are good
- fairly boring
- fairly boring topics
- find teacher's lessons quite boring and I haven't learnt much this year
- fun and easy to understand
- getting harder
- getting more enjoyable
- good
- good amount of practicals
- good fun
- good good

- good teacher, boring subject
- got good grades
- great
- great!
- hard
- hard to remember some things
- hard, but enjoyable
- hate physics!!
- helpful for working up to the exams in November
- I am enjoying physics and am motivated to continue at higher level
- I definitely enjoy the practicals along with the theory
- I did not understand anything in P7
- I dislike physics because it's hard
- I enjoy doing P/b more than P/a
- I enjoy physics
- I enjoy physics a lot more because of my teacher
- I enjoy physics and find terminologies easy to recall, and the theories are easy to remember so it is a good subject
- I enjoy physics as a subject, but I find that our lessons are not well explained and not stimulating.
- I enjoy relevant practicals
- I enjoy them
- I enjoy them a lot
- I enjoy them and they are well structured
- I enjoyed learning new things
- I enjoyed them more than I used to
- I feel they are much more interesting than the actual topics, they are made more interesting to me anyway
- I find it good for knowledge but I don't see the use.
- I find it interesting and very useful
- I find it very confusing, but my friends are most helpful at explanations
- i find p1b more interesting
- i find the lessons good because there is a lot of practical lessons
- I find the maths aspect hard but the rest are ok
- I found it quite confusing
- I hate them! and my teacher can't teach me
- I have enjoyed physics lessons, as the demonstrations make the lesson enjoyable and therefore it's easier to learn
- I have found lessons generally difficult
- I have found them very rewarding and captivating
- I have improved and gone up by a grade since last year
- I have improved but still find it hard
- I have learnt a lot and I feel more confident in physics
- I like learning about current physics issues
- I like my teacher, he's really intelligent
- I like physics
- I like physics
- I like physics! at times
- i like solar system
- I like the facts part, not the formula part of physics
- I like the subject as it's always different
- I liked doing practical, rather than copying notes

- I love my physics lessons!
- I love my physics teacher he's great
- I love my physics teacher he's great
- I love science and my teacher is the best I’ve ever had although I am starting to find it very hard and boring
- I love them
- I really enjoy my physics lesson as I enjoy learning the new topics.
- I struggle with it a lot
- I think I prefer chemistry
- I want longer time and projects on space
- I wish we had more than just one term
- I would like to do more practical
- it confuses me!
- it has been fun
- it has been really interesting
- it has been very interesting and engaging
- it hasn't interested me in any way
- it is quite difficult
- it needs to be more fun.
- it's a challenge but fun
- it's amazing
- it's better without boys
- it’s boring
- it's boring
- it's boring
- It's good if I liked physics
- it's got a lot harder
- it's not too interesting, sometimes it's boring but it's ok
- it's not very exciting, too complicated
- it's quite good.
- it's so awesome
- it's the worst subject ever
- jam-packed
- learn a lot
- learned a lot from my teacher, she is a very good and dedicated teacher and she cares about year results
- learning about it so seriously and in depth has taken the interest out of it. It is just lame now
- learning the different types of formulas are quite hard
- lessons too hard and boring
- looking forward to the module about space
- love it!
- lovely
- maybe some games would help
- momentum is hard
- more interesting and enjoyable
- more investigations
- more practicals!
- Mr X’s method is best
- Mr X's method is the best
- much better thank you

- much easier, more chance to speak
- my physics teacher is amazing
- My teacher does not make it fun or interesting
- my teacher is boring, doesn't seem to enjoy teaching
- my teacher is enthusiastic so this rubs off on me. I worry about taking it further in case I don't cope
- need to do more independent learning - listening to teacher gets tiring
- need to do more practical work
- need to slow down a little sometimes
- needs to be a bit more lively, more fun!
- needs to be more fun
- none
- not a lot learned.
- not a lot of practical work
- not enough practical work
- not enough practicals
- not explained properly, go to quickly
- not many interesting topics, good teacher
- not motivating enough (mainly the teacher), too much book work, slightly boring
- not really enough time given to actually memorise the information or understand it thoroughly
- not really
- not really
- not very good, not structured
- not very inspiring, needs more practical
- not very inspiring teaching/teaching methods
- not very motivating + too much book work, not enough practical. dull
- nothing
- organise things better please
- our work time has been cut by weather conditions.
- overall it has been extremely boring
- physics for the win
- physics is aimed for boys!
- physics is better than chemistry and biology
- physics lessons are informative and the subject as a whole is very interesting
- physics sucks
- physics teacher needs to be more inspiring, we don't enjoy his lessons
- pleasant
- please make it more understandable and fun!
- pretty boring
- pretty fun
- put boys back in
- put boys back in, easier to concentrate
- quite interesting
- really enjoying my physics lesson!
- should do more on space/universe/stuff like antimatter/architectural stuff/future
- some things aren't explained well enough. Moves on too quick
- standards of faculties, boring
- standards of laboratories
- struggling - complicated
- teacher could explain things a bit more
- teacher doesn't enjoy teaching us and we haven't learnt enough

- teacher is a good man and teacher
- teacher is a good man!
- teacher is funny
- teacher is funny
- teacher is good
- teacher is nice
- terrible teacher, haven't learned anything
- they are excellent!
- the last few lessons have been quite interesting
- the lessons are better with girls and no boys
- the lessons are fine I just find physics one of the hardest subjects so therefore I'm not interested - quite pointless.
- the sooner they're over, the better
- the teacher is good!
- the teacher makes it fun
- the topics are not interesting than before
- there are formulae to learn
- they are boring
- they are boring and the teacher was crap
- they are fairly good
- they are fast but good
- they are good
- they are great
- they are interesting.
- they are really good but I feel extremely withdrawn from the group
- they are so dreadfully dull. I enjoy light and sound though
- they are taught at a good pace
- they are the same throughout
- they are very enjoyable
- they are very interesting
- they are very interesting!
- they are very interesting, I never thought they'd be so much fun
- they are very rushed
- they could be more interesting
- they have been boring
- they have been enjoyable as I like how we discuss things
- they have been really fun and I enjoy them a lot
- they have improved
- they rock!
- they were fun
- they were informative
- they were quite good and interesting
- they were quite interesting
- they were rubbish
- they were very effective in me getting a good grade
- they're alright
- they're awesome
- they're better than before
- they're better than before
- they're good and interesting

- they're good because they're very interactive and we get to do lots of things
- they're interesting and practicals are fun
- they're okay
- they're okay but I just find them hard
- they're quite interesting
- things become much more rushed nearer to exam time (Jan)
- think things through more
- too many formulas - not enough theory
- too much homework
- too much maths, need more trips and documentaries etc
- too much practical
- too much practical
- too much rote learning, no time to think, or allow individual interpretation
- topics are a bit dull
- triple science is difficult
- very boring subject, not enough discussion time in lessons
- very boring, no experiments, just sit and study
- very difficult - links to subjects like maths
- very easy compared to last year in top set
- very enjoyable, fun and interesting
- very good
- very good
- very hard and boring
- very interesting
- very interesting
- very interesting - discussion is the best
- we could do with more time so that we don't have to rush through topics
- we don't learn anything!
- we don't spend a lot of time on each subject
- we leave the writing to the last 5 minutes which is a rush!
- we move on a lot quickly
- we should do more about space
- weird teaching methods, sometimes work well (refractions of light) not always (DLD with cameras)
- we've done the exams so lessons are limited right now...

Appendix 5.2

Teacher Questionnaire 2 Answers to Open Text Questions

Please explain how you feel about the usefulness of Action Research:

- *It helps you reflect on what you have planned and how effective you perceive it to be. Asking pupils their views of improving the ways they learn and enjoy physics.*
- *It allows you luxury of being able to trial new interventions reflect on their effect and modify this intervention.*
- *Better knowledge of a range of interventions and resources that I can use within lessons at both KS3 and KS4*
- *Action research may have a only a slight impact in improving classroom practice as the cohort of participants is small and the intervention only localised.*
- *In a lot of ways this is what a reflective practitioner does. It just formalises this process.*
- *It has made me think about how I teach different classes and different abilities.*
- *It enables me to look at the way in which my own practise affects the pupils and what I can do to improve their learning experience*
- *It has made me engage in the subject as I have had to think of different ways of making it relevant.*
- *It has been useful finding out the difference between my delivery and what the pupils have understood. Less useful though has been the knowledge that I may have increased the uptake of Physics at KS4 but made a rod for my own back because pupils who would otherwise not take Physics believe that it is do-able and easy. I now worry about my KÂ£4 results.*
- *My view of the action research methodology is that it is a formalised version of common teaching practice; all teachers plan, implement and reflect and evaluate learning activities - this is simply good practice. The AR methodology is good for making tacit assumptions more explicit and connecting them to a theoretical knowledge base.*
- *The idea of looking at different research questions and interventions is useful and a habit I would like to continue. I would prefer not to do it as formally as the time taken to process results and produce a report would be prohibitive for the amount of new approaches I would like to try. I would like to continue to engage in a smaller scale type of action research.*
- *It gives motivation to try change the opportunity to discuss practice with other teachers and the freedom to experiment*
- *I feel i had a successful project I wonder if I would feel as positive with a poor set of results.*
- *explain what ?*
- *Ideas of others involved in the research have given me the motivation to try out some of their intervention strategies*
- *The Action Research is a catalyst to question current practice and is a stimulant to innovate in the classroom. Such things would be possible without the structure of an Action Research project but would not necessarily happen without the motivation conferred by a structured programme.*
- *Highlights areas of improvements in my teaching and my pupils learning. Gave me the opportunity to experiment with teaching ideas and analyse my findings*
- *I have always been an enthusiastic and confident teacher. The Action research project has given my professional development a particular focus which I have found very useful.*
- *I feel I have learnt quite a lot of the past 18 months. The project has helped me understand the pupil better and what they want out of lessons. I have been able to improve my own practice as well especially with regards to behaviour management.*
- *The discussions with other colleagues provide an opportunity to learn about new good practices which I then went away and tried. Feedback from pupils helped me plan for future lessons.*
- *Since I started the action research my confident have increase to the extent that I am more able to challenge pupils about their misconceptions about physics. I am able to maximise physics interaction between boys and girls tried new things which I would not have attempted in the past.*

- *Useful to have the opportunity to focus on something specific to my classroom and teaching.*
- *I already knew what Action Research was before starting the programme so haven't learnt very much new information. It can be time consuming but can also be useful to inform my teaching and get new ideas.*
- *It makes me consider the approaches I use when planning and delivering all of my lessons. It gives me time to think and time to listen to academics and teaching colleagues.*
- *The action research approach provides a framework for focusing on a particular area and then giving a start a middle and an end. The end then also encompasses review of the outcomes (which can then feed back in) and consideration of the requirement to share findings (together with something more structured to actually share).*
- *Even though I don't feel my particular question was necessarily answered in a positive way I have definitely increased my confidence in trying!*
- *Physics action research has been a great opportunity to share my findings reflect on my own teaching and gain an insight and be inspired by the findings of other teachers.*
- *There have been things that I have tried out that have had an impact on my practice in the classroom. My practice will change as a result of things that I have done. I feel that the pupils are more aware and interested in physics. I have also been able to cause a change in the external environment that will hopefully have the WOW factor.*
- *I have found it hard to accept that in this type of research you can alter the parameters mid programme but have actually found that to be quite refreshing. The lack of a decisive 'This is the answer...' is a little frustrating but makes me want to continue to see what future impact my intervention may subsequently have.*
- *The research has shed light on other aspects of children's experience of learning physics e.g. inability to link physics to the world around them. So classroom practice is improved because there is more focus on the relevance of the physics they learn in the classroom.*
- *Taking the time to look at pupils views of physics has made lessons more context based*

- *I found the particular subject of this particular ARP (into what pupils need to study/enjoy physics) very useful. I also found the time attached to reflect on my practise very useful and some of the findings were unexpected - I would not necessarily have otherwise realised that is what I needed to do. I did not feel I had enough time to intervene as effectively as I could have done with my particular cohort - with better planning I feel it would made more of a difference.*
- *It has opened my eyes to strategies to improve my teaching and learning. |It puts pressure on you to think about your teaching practice what you're doing and why instead of just putting your head down and getting on with it.*
- *Encourages reflection and use of new ideas. Difficulty is in time to do it all and poor prior experience of Physics meant pupils were very difficult to motivate.*
- *It is useful if you have time to do the background research so this course was extremely useful but without allocated time it will be difficult to repeat on the same scale.*
- *Being involved in Action Research means that I have the opportunity and time to review/investigate areas of interest to me.*
- *Focus improved.*
- *TIME to reflect, introduce interventions and evaluate*
- *Quick responses; fast additions/changes to SOWs etc. Sparked enthusiasm for reflective practice.*
- *Reflection improved planning. Money improved resources.*

86% of the teachers said that they have made changes to their classes as a result of the programme as a whole. Discussion time in classes was increased by 72% of teachers over the course of the programme and reflection time by 57.8%, a distinct difference. Half have changed their Schemes of Work.

Please outline any changes you have made to your practice as a result of the Action Research for Physics Programme.

- *I try to reduce the amount of time I talk in lessons so the pupils can lead their own learning.*
- *Increased awareness of putting myself in the pupils position.*
- *What didn't work was to give lessons that had a major focus on careers in physics as this did not stimulate as much interest as expected. Using careers briefly in lessons but on a more frequent basis had a better affect especially when related to the lesson topic.*
- *I try to include as many examples of careers and real life examples in lessons now.*
- *I found that I spent more time discussing Physics and Physics related subjects with pupils.*
- *To give short humorous anecdotal - not more than 5 minutes. Give pupils the opportunity to understand everyday scenarios*
- *I will continue to use Media as examples of how Physics is relevant and to engage discussion. I am not sure I am not sure I always.*
- *Mathematics calculations with formulas have not worked on their own. However repetition of the concepts linked with the maths have made more of an impact. For example the pupils know that when I tell them we will be doing graphs to ask "what type of graph it will be". They however do not like line graphs.*
- *I have planned and used some small group discussion activities. Some of these worked well and some did not. Some of the tasks were too challenging but some were pitched just right. The pupils enjoyed having the opportunity to discuss physics problems together. I will certainly use more small group discussions in my physics lessons in future.*
- *I am going to develop ways of teaching the Maths of Physics in specific ways that encourage pupils' confidence rather than relying on the Maths department to cover these topics.*
- *Less prescriptive style of teaching. Use of feedback from pupils as well as feedback to pupils*
- *Relating topics to careers early on in teaching each topic to show where this module mat be relevant.*
    - *regularly exposing pupils to non-curricula 'exciting' Physics e.g. Big Bang relativity quirky characters etc. & measuring impact*
- *What worked was getting the pupils to realise that science/physics is interesting and enjoyable and it made me look into other ways of motivating pupils into wanting to know and learn more*
- *The resources which were researched and generated are now available for routine use by myself and other colleagues which will hopefully result in enrichment of the experiences of pupils associated with Physics lessons and lead to increased post-16 uptake.*
- *It highlighted the success of mixed gender grouping if carried out correctly. It open up 'pupil-pupil teaching roles' give G&T opportunities to extend their knowledge and finally apply physic to everyday examples.*
- *I am much more aware of HOW pupils learn as well as what they learn and this has shaped the way I tackle some of the more theoretical aspects of the topic.*
- *I use more resources (starter/plenary activities) from outside sources. For examples other websites rather than sticking to the resources we have at school. I felt the project worked and working in single sex groups benefited the group as a whole. However the girls certainly benefitted more from this they were a lot more engaged and focussed on their work and what they needed to do whereas the boys although they were not distracted by the girls were still able to distract themselves and sometimes struggled to stay focussed.*
- *My questioning has changed. I am now giving pupils thinking time which helps them to think through the questions and as a result phrase their answers better. My language has also improved as I am using every day terms before introducing technical terms.*
- *My triple science pupils are more confident about the subject. My questioning techniques and language use throughout my lessons are more differentiated to meet the ability and learning style of my pupil. Most of my pupils especially the girls are opting to study physics for A-levels*
- *I found the process of holding the conversations with pupils was very useful however it highlighted that I need to develop more opportunities for the class to develop independent learning skills*

- *Use of mini whiteboards in lessons. Thumbs up/thumbs down. Giving pupils more talk time in lessons although no easy with constraints of curriculum.*
- *Using concept maps to consider the best order to teach lessons in so that they flow well and key concepts are taught and understood before progressing to the next set of concepts. Giving concept maps worked fairly well in giving an overview of the topic - it was even better for pupil revision. Teachers have also found the maps helpful in their planning.*
- *The modelling had a measurable impact on the learning outcomes which has encouraged me to continue to use this as a method of developing and disseminating work with my classes.*
- *I am using increased wait time (or rather learning to!) using no hands up much more often trying some great ideas from research encouraging some girls to produce a careers in physics notice board.*
- *I use mini white boards in a different way - results of research findings from my pupil researchers. I use pupil voice more. I really avoid using a hand-up approach.|*
- *Use of interactive boards not just to get quick responses but to also get responses from open ended questions. Use of stimulus to generate questions from all of the class meaning that pupils are not becoming dominant in the lesson or taking a step back. Creating the mural has inspired me to look at creating other art work with the kids about science. My visit to the Hadron Collider has shown me that though this was a trip for me the experience can be shared with others. Where pupils had to design the next lesson I will try and use this more in my practice as the pupils do have good ideas to extend and help their ideas of physics.*
- *Tend to set up practical work at beginning of lesson and let pupils consider implications. Incorporate short practical hands on activities wherever possible (or Hollywood style film clips then discuss physics of them)*
- *At key stage 4 teachers now have information about related resources that they can access from a lesson to lesson scheme of work. |AS physics pupils have attended talks with pupils from other schools through the CLSPS network. |*
- *More links to life resources/clips with presenters pupils know (top gear) to increase interest*
- *Introduced a careers lesson for all Year 10 triples pupils*
- *More thinking time allowed for pupils in lessons - very specific outcome identified for them. |More STEM activities are planned for pupils in future years to make Physics more fun and relevant for them. ||Planning of intervention could have been timed better - did not have time in the final half term of the year and that was not previously anticipated. I still feel I need to link Physics more to the everyday lives of pupils.*
- *Classroom practice - using mini white boards. Being more aware of what pupils are doing during lessons*
- *Allowing discussion time then silent writing time. Using AfL resources to see who needs support. Mini-whiteboards.*
- *Outside speakers worked well as motivation as did 'wow' experiments although I didn't do more experiments just assessed their impact. More structured lessons for yr 12 and more individual broken up tasks with individual scores/ feedback. More project work with peer/group assessment. More reflection on gender differences in yr 12.*
- *I am including discussion about how the Physics being taught relates to jobs/careers.*
- *I would like to introduce 5/10 minute slot during faculty meeting to talk about physics teaching.*
- *better course organisation; more prac work; pupils more reflective about their learning; more involvement with outside agencies.*
- *Better displays; more communication - careers - assemblies - powerpoints; more visitors (Starchaser rocket; employers, previous pupils; new club); more reflection/monitoring with questionnaires.*
- *More ideas taught before "language"/equations/terminology; using metacognition to enable pupils with L2L.*
- *SOW are so important.*
- *more practical0*

- *Made lessons context-based - fitted physics in around that. More time for discussion + group work. Frequent references to careers.*
- *Introduced careers-focussed activity into Year 8 science programme.*
- *The careers information definitely increased engagement of pupils. I will be trying to include careers information to younger years so that they can make longer term decisions.*
- *Presentations from people in the job had a bigger impact than pupil research into careers. Role models are very useful to bring into the classroom where possible.*
- *Most of the pupils were engaged with the project but I was surprised to find that some pupils did not have access to the internet at home. I was pleasantly surprised to find that pupils were able to find some very interesting aspects of physics to share with each other.*
- *I am far more focused on how physics is used as I teach the topics rather than here is the Physics and at the end this is how it can be used.*
- *To teach pupils the basics of problem solving and to encourage far more collaborative learning and pupil-pupil discussion.*
- *I began to tackle to conceptual "Big Question and Bigger Question" topic descriptors at the beginning of a new topic. I have begun to think of new ways to engage pupils by using their own understanding and perception of the world as a starting point.*
- *I have learned that able pupils are sometimes/usually able to look and take an interest in things which I thought they would not understand. I would definitely continue this practice.*
- *Cooperative learning strategies embedded in everyday practice - becoming the normal part of my lesson planning and learning activities for pupils.*
- *I will focus more on using VLE technologies to promote revision activities rather than with them (in the first instance at least) as a tool for week-to-week working*
- *Changed emphasis slightly. I have always been the most practical (active learning) based teacher in the dept. I have made own resources in the department and will continue to do so.*
- *I am more passionate about effusing change because I have seen evidence of its impact on teaching and learning.*
- *By making physics more simple and relevant to everyday life*
- *Always try to highlight whether studying physics chemistry or biology in KS3 and KS4. Try to make more reference to possible jobs.*
- *Again it did not change practice as it was not really linked with the classroom*
- *Learning about resources available to promote science careers and integrating them into teaching practice*
- *I found that teaching relationships between quantities by pupils getting a physical feel for them themselves before relating this to the relevant equation increased pupils' understanding of the relationship and therefore how to use the equation.*
- *More linking of physics concepts to physics careers and new physics such as what is happening on the news.*
- *Haven't changed my own teaching style but having applied it to teaching GCSE physics will now write it into SOWs for other teachers*
- *Giving pupils a hands on approach to solving problems and sharing ideas. collaborating with other departments (STEM)*

Please briefly outline any changes you have made to your classes as a result of the programme:

- *The way I teach it the resources I use and listening to the feedback the pupils give.*
- *Produced a careers lesson for the department. Modified existing schemes of work in response to pupil comments.*
- *Now include information on careers on a more regular basis with better use of specific case studies*
- *Group work more 'games' based on the keywords more hands on work.*
- *The classes seem to understand how physics can be relevant in their lives and some find it more interesting*

- *using media eg videos newspapers Ict*
- *When the lesson requires calculations I have tried to simplify with words and demos before introducing the calculation/formula*
- *I now use examples that are not so male-oriented e.g. when discussing forces and acceleration I now refer to animals instead of cars. I try to make more explicit links to applications of physics at the start of learning activities instead of as an add-on at the end of a lesson. I avoid teaching the equation first and then the physical meaning of it. Now I teach the physical meaning of a concept and define it only after I have done this. I have gained some ideas about physics careers that I will include in my lessons in the future.*
- *I have started to incorporate some of the ideas from the other participants into my lesons. Eg. increasing relevance highlighting career opportunities increasing the 'wow' factor.*
- *Less prescriptive style of teaching. Use of feedback from pupils as well as feedback to pupils*
- *I am in talks with our STEM ambassador rep. (Peter Tribe) to talk about how we can make this a regular activity - In all STEM subjects.*
    - *regularly exposing pupils to non-curricula 'exciting' Physics e.g. Big Bang relativity quirky characters etc. & measuring impact*
- *Ideas shared by other delegates have been applicable to my school and elements of their practice have been integrated into lessons at my school*
- *It has shown how important group work is to teaching science but also apply physics to interesting concepts that pupils aren't even aware of.*
- *Fewer questions to the whole class. More independent finding out from the pupils.*
- *I try to increase engagement in lesson to the class as a whole and sometimes target individual pupils or pupil groups. I have increased the number of different activities I do especially with regards to starters and plenaries.*
- *I am now taking into account observations from my project to adjust or plan my lessons so they are pupil centred to ensure learning occurs.*
- *Questioning and language use in my physics lesson has improve to the point that pupils of all ability are able to relate to every day uses of physics in their social lives.*
- *Changed structure of lessons. More use of pupil voice.*
- *Use of mini whiteboards in lessons.*
- *Giving pupils concept maps before embarking on a new topic.||Using these maps to revise from.*
- *Have taken on board interim findings from other members work (eg single sex groups involving pupils in planning course content) and used them in my school*
- *It has made me look at my own practice research other techniques and try them out.*
- *I use mini white boards in a different way - results of research findings from my pupil researchers. I use pupil voice more. I really avoid using a hand-up approach.|*
- *I am constant looking at ways to get pupils interested in physics and science. I have thought about things that I can do in the classroom that will explain things to the children in a way that they understand. I have thought about ways that I can engage the pupils that I teach.*

- *Ensure that career based examples are used as often as possible; Inform A-level pupils about events taking place (CLSPS site)*
- *All triples pupils in Year 10 are now taught a careers lesson*
- *More awareness of other factors that influence girls' understanding of physics - allow girls to see the bigger picture by reinforcing links between topics ensure Physics is introduced in a context relevant to girls use of relevant analogies in teaching.*
- *More thought has gone into my teaching and learning - due to reading and questioning what I am doing and why.*
- *Allowing discussion time then silent writing time. Using AfL resources to see who needs support. Mini-whiteboards.*

- *More structured lessons for yr 12 and more individual broken up tasks with individual scores/ feedback. More project work with peer/group assessment. More reflection on gender differences in yr 12*
- *Sharing ideas with colleagues enhances any work in the class.*
- *More reflection, more monitoring, more context.*
- *-Changes to SOW/discussions with colleagues; -regular questionnaires to check confidence.*
- *Careers knowledge + promoting science as a preparation for their future. More practical work.*
- *more practicals whole class*
- *Introduced careers-focussed activity into Year 8 science programme.*
- *Appreciation of how linking topics to careers can increase engagement.*
- *Use girls' ideas more. Use their language to describe things and refine later. Crowd busting is not so effective but occasionally useful.*
- *Participating in the programme makes you think more carefully about lessons - changing the emphasis away from 'what am I teaching?' to 'what are the pupils learning?'|*
- *New introductory lessons focused on applications.*
- *Do you mean in terms of results or how I teach them?*
- *Lessons are more about why they are taught as opposed to what is taught; Pupils are seeing physics as something different, not just good or bad.*
- *Not to all classes - but I am keen to discuss "big ideas" with them.*
- *Pupils are working in teams to support each others' learning*
- *Not in terms of the lessons, but the fact that all pupils (in theory if not at the moment in practice) can access a whole range of revision resources & activities I hope will have some effect as we get closer terminal examinations.*
- *More sympathetic to (perceived) problems in understanding - more aware of pupils' lack of MATHS skills holding them back. More aware of me pushing the relevance to life/careers etc.*
- *Careers incorporated more firmly. I teach the maths before the science to remove that barrier.*
- *Most groups and teachers now using diff.tech.to teach physics*
- *Care with language used e.g. always trying to find an equivalent non technical term. Trying to make more relevant to everyday life.*
- *tried to introduce related careers whilst teaching the different topics*
- *I give more examples of where the topic being taught is relevant to careers*
- *Only slight changes to my main lessons such as a greater awareness of how relevant my teaching is appearing to the pupils*

Please specify any changes you have made to your schemes of work:

- *Electricity GCSE scheme of work was modified and adapted as a result of pupils comments regarding repetition of topics/practicals/over use of equipment*
- *The year 10 and 11 SoW is under review for the new GCSEs and will incorporate many new ideas of mine and other participants*
- *I have included the resources I used to delivering specific topics in the schemes. This is ongoing.*
- *I have embedded a discussion activity about different energy resources in the SoW.*
- *I wrote a new year 9 scheme of work for electricity which aimed to increase relevance to pupils.*
- *Some activities have been shared with colleagues for them to try if they want*
- *8J moving on (exploring science) is now based around formula one and how speed drag friction and magnets can be shown in this example.*
- *I more or less ignored it and taught the content in my own way!*
  Some (but not all) of has to modified. Most of my pupils are enjoying researching the topic before it is taught in class all due to my action research.
- *Modelling has led to reorganisation of new modules as developed. More focus on understanding of misconceptions research and using these to impact on course structure.*

- *I re-wrote my scheme of work for P6 Waves and Radiation in 21st C Physics to incorporate objectives and plenary questions for each lesson.*
- *In previous projects of the action research I have tried a number of things that have meant changes of the whole department such as researching careers in science and physics*
- *Updated the ks4 schemes of work to include careers and context led lessons. There are also links to e-resources. The schemes of work are a day to day document*
- *Scheme of work written for case study coursework to highlight wider links of science/physics.*
- *Greater clarity in SOW in Energy topic.*
- *More prac; better organisational framework for pupils.*
- *faculty meeting dedicated to improving schemes.*
- *wrote more practicals in*
- *Rewritten module.*
- *Introduced careers-focussed activity into Year 8 science programme*
- *All teachers will be asked to use the introductory applications lessons*
- *Big + Bigger Questions at start of topic.; Trying to cut down SOW to remove unnecessary lessons ore condense lessons; Including more real-life science and discussion than SOW currently permits*
- *Already underway but KS3 now fully +formally condensed to 2 years with final assessment in Nov Y9. KS4 now taught from Jan of Y9 (done while I was acting HoD).*
- *I have written a brand new SOW for core science physics*
- *MORE AND more questions and simple and easy to understand experiments*
- *I will do when writing schemes for the new GCSE next year. I will also encourage other physics teachers to do the same.*
- *I will make changes to the scheme of work this will involve writing in the new 'cutting edge' lessons into the main scheme so that they can be repeated every year.*
- *Schemes will emphasis simple practicals and analogies to use how to get pupils to derive own relationships and understand proportionality. No starting the lesson with an equation displayed.*

Do you have any remaining concerns about teaching physics?

- *Not with the teaching of Physics but I am concerned that Physics could be losing out in a restructuring of science teaching in general as the new GCSE course is introduced ie there is talk in my school of having Physics as an option.*
- *content and testing modes at GCSE*
- *I believe we need a deputation to institutions for higher education to impress on applicants that Physics although not strictly needed is desirable especially in these days of competition.*
- *How to incorporate all of the ideas within the constraints of syllabus delivery and exam and coursework deadlines.*
- *Traditional methodology used in GCSE Physics course. Relevance of material to students and future careers*
- *The more I improve my subject knowledge the more I realise I need to learn.*
- *only day to day ones!*
- *Main concern is making all of the physics content in 21st century science relevant to everyday life*
- *Mixed groups tend to be more focused during the tasks.*
- *Students seem not to be aware of careers and futures in physics.*
- *subject confidence at A-Level*
- *I still want to make more links to careers in physics.*
- *Feeling more confident now about an action plan. Did SASP Physics course alongside the action research and both have been v. beneficial to my confidence.*

- *Yes I want to increase my confidence levels further and also need to improve my understanding of the P7 topic as I have not taught this before.*
- *I feel that the battle can often be from external stimulus such as people thinking science and scientists are geeks.|*
- *Not at GCSE*
- *I would like to be able to change more students negative opinions of physics*
- *Yes;|Confidence in topics; strategies; ideas to illustrate concepts. I would value support in teaching of physics to all levels from year 7 to GCSE.*
- *Still looking at strategies for pupils who struggle with mathematics and concepts to allow differentiation from A* to E grade in the same lesson.*
- *I think my next step would be to find more examples of where physics works in the pupils' environment. Some pupils do still comment that physics lacks relevance to them.*
- *My base line data seems to indicate that students have clear views about physics and whether it is for them at the start of KS4. I am interested if an intervention during KS3 will affect these views.*
- *More support inside schools is required as well as from bodies outside education like ZoP and especially the Govt.*
- *I still feel that KS4 physics is very dry and I hope that the Y8 pupils I have worked with won't get put off physics at KS4.*
- *I don't, but I do have concerns that when taught by people out of specialism there is a tendency to teach it badly.*
- *I still feel physics is very engaging and interesting at KS 3 but when we get to KS4 its curriculum lacks sufficient contemporary subject matter and drifts too much into areas that would easily (and sometimes are) taught elsewhere.*
- *For myself no, I have always been enthusiastic and confident. Confidence of other staff (IF staff in particular) has improved.*
- *More hands on CPD activities are required to improve reading competences.*
- *My issues are still mainly with my own confidence and ability as a non-specialist teacher of physics.*
- *pupil perception that it's hard and there are softer options that will get them guaranteed A grades - difficulty getting them to believe that a B in Physics could be worth more than an A in Psychology*
- *Teaching pupils to enjoy understanding physic equations.*

Any other comments?

- *Whilst using careers as an intervention has proven useful |the action research programme has now made me look at other methods of intervention and ways to change my teaching practice in physics*
- *I have enjoyed the sessions and generally talking about the teaching of Physics with other teachers.*
- *A thoroughly enjoyable project*
- *I find one of the most useful aspects of attending courses is the sharing of ideas with colleagues. Fresh ideas are always inspiring.*
- *A very useful piece of CPD.*
- *A really good piece of research since taking on this research I have become Head of Department in my school and would love to encourage colleagues to do the same research. Will this be on going? and if so the financial incentive made this much easier to get permission from SLT to allow time out.*
- *thank you !*
- *I feel very inspired by the intervention of others on this course*

- *Mixed groups approached the task in a more organized manner and were able to remain on task due to constant prompting by individuals in the group. |â€¢*
- *I have found the project a very enjoyable and satisfying experience. I have gained valuable information that I will continue to use and apply to my teaching practice. The resources I have gained have been brilliant.*
- *I intend to develop this awareness to careers in physics by linking it with the teaching of physics.*
- *Would be really useful to have an online resource where we could leave our resources that we have created for our action research for others to trawl and use. We have talked about sharing them in the group but I am sure there are great ideas from other sites as well. Would be lovely not to have to keep reinventing the wheel and for everyone's hard work to be used more widely.*
- *It is very nice to receive positive feedback from Physics colleagues on the course. As the only physicist in school it is pleasant to share ideas with other physicist.*
- *I have thoroughly enjoyed being involved in the project over the year and have found that I have gained a lot from my involvement.*
- *Thanks for all the support!*
- *Being part of the project enabled me to work with like minded people who all want to improve physics education. I work along with one other physics teacher so it was good to get out and meet physics teachers from other schools and colleges. The facilitators have been first class - supportive positive and encouraging and really made the project worthwhile and meaningful. The training days were very helpful and enjoyable.*
- *I think the timescale for carrying out the project was a little short as for more measureable outcomes I need to run the project for the whole of KS4 and to have time to see how it affects A level numbers.*
- *I have been pleasantly surprised by the fantastic ideas my Yr 8s have. It shows that there is loads of physics which pupils naturally find interesting, which is not in the national curriculum.*
- *IOP have stepped away from the Advancing Physics A level, and I really hope they will be as highly involved in A level in general so that physics is well supported.*
- *I would like to know more about practitioner research that comes out of other subjects.*
- *The whole course has been shortened? (was 18 months initially - now 13 months). Been excellent meeting and interacting with other members.*
- *This project would have been much better with more research time with my focus group.*
- *It has been great having the opportunity to know about the range of issues highlighted by previous studies especially the girls in physics and in many small ways I am trying to tackle the issue.*
- *I thoroughly enjoyed my action research project*
- *Some things haven't changed yet but I am sure will do such as sharing new good practice with other teachers.*
- *Vital that time is given for collaboration with other researchers to get ideas on what works well*

Appendix 5.3

CPD Managers' answers to open text questions

What is your understanding of the teacher's intervention and the impact it has had?

- *Raised profile of physics within faculty, especially at KS3. Resources have been used well to engage pupils and stimulate enthusiasm for physics*
- *Research into motivating pupils in physics by developing coordinated cross-curricular programs of study. - Huge benefits in terms of motivation and enjoyment of physics. - benefits to teachers - having the creative freedom to work together on a common project.*

- *Investigating alternative approaches to the delivery of KS4 physics. - Development of creative, pupil-centred programs of study. - Increased motivation & enthusiasm for physics by pupils. - Improved academic progress on modules taught using new methodologies.*
- *-Has been researching the most effective ways of group-work. - Made big difference to teacher's confidence, self-esteem and enthusiasm for teaching physics. - Has had major impact into the way group-work is set up in lessons. -Has benefited from working with other physics teachers. - Development of new T&L strategies.*
- *The main focus of the intervention planned by teacher is the production of a video to promote engineering/physics in collaboration with a local engineering company - "David Browns". The video has not yet been completed - it should be in place by Easter. The video is being produced with the help of a specialist production company "Small Cog Productions" and when complete will be shown around schools in West Yorkshire. Impact will not be known until afterwards.*
- *Impacted on knowledge & skills through school INSET on energy transfers. Impacted on practice through a greater confidence in practical sessions especially in using photography to illustrate ideas. Impacted on school through an increase in faculty willingness to share ideas plus an improvement in pupils' attitudes to Physics. Impacted on pupils through greater understanding of the topic as demonstrated through pupil questionnaires*
- *Schemes of work have been amended and activities added to encourage pupils to consider Physics/STEM careers with focus on girls*
- *Teacher has targeted Yr10 triple science groups and delivered specific lessons on careers leading on from a physics qualification. He has taught lessons on "introduction to particle physics" which would not normally be covered at GCSE and he held a live video conference with CERN after school which 20 pupils attended voluntarily. At the planning stage the lessons linked to computer game physics, materials and astronomy - linking with new evening astronomy club which has been set up. IMPACT - awareness raised about all aspects of relevance and importance of physics assessed through questionnaire and interviews - will be followed up at end of year. Number opting for A level physics from Sept 2012 will be ultimate test of impact.*
- *Exposure of pupils to non-curricular physics. Data gathered did not show much impact but it is difficult to measure impact by using data*
- *The classroom intervention focused on pupil attitudes to physics and how it could lead on to future careers. This intervention is starting to raise awareness of the relevance of physics in the careers market. This is a long term project but we may have some evidence when we see take up numbers for AS physics this year.*
- *The research was based on the uptake of girls in physics post-16. A range of activities were designed to increase awareness and interest of the cohort of girls including working with STEM Essex, this was also supported by the teacher exploring different teaching approaches including clear links to careers. The teacher's additional confidence in teaching physics was augmented through attending a 4 day course at the NSLC on physics for non-specialists, it also linked to a visit for the teacher to CERN. Teacher has contributed to published articles, conferences and school CPD, pupils have already benefited.*
- *Teacher has been working on some sort of physics impact research since starting at this school. She's constantly trying to raise the profile of science/in particular physics. she has strongly encouraged girls to do physics. It is very difficult to see the impact of this project as the intervention has been ongoing.*
- *Pupils trialled rotational teaching with subject specialists. No difference in GCSE results. Pupils unhappy with rotation.*
- *It has enabled the teacher to have greater impact on individual pupils and their learning by tailoring teaching resources and approaches to have the greatest effect on improving learning.*
- *The teacher has tried to raise interest and awareness of physics careers for all pupils (specifically girls), by relating to practical applications and pedagogical methods.*
- *The teacher wanted to increase the numbers taking A-level Physics and this has been achieved successfully - has increased from 5 to 23 and we await numbers for next year. -Helping*

underachievers boost their technical vocabulary (GCSE level). As a result, their confidence has improved.

- *Pupils were enthused about applications of physics. This may lead to increased uptake post-16 but it is too early to say.*
- *Teacher was looking at attainment in AS and uptake into year 13. Attainment has improved using the following ideas: -exam question booklets; - better prep for internal assessments; - topic summary sheets; - more involvement with outside agencies. Take-up and attainment have both improved. There is a very positive pupil voice for AS/A2 physics within the school.*
- *Introduction of the importance of physics in the real world to encourage a greater number of pupils to follow a physics course at KS 4+5. Whilst pupils understood the relevance and importance of physics they still did not want to study it as a separate subject.*
- *This teacher is leading intervention in science at our school. She has a great impact on intervention + strategies used within the classroom. Results show a positive improvement with intervention.*
- *For us, the impact was minimal as the delivery was confused with the exam specification delivery.*
- *Change in techniques (discussion of timings and writing); traffic lighting; mini-whiteboards; contextualising*
- *The teacher was trying to increase motivation for physics at GCSE and A level by showing children the career possibilities that are linked to physics and to stress how physics topics fit into the 'real world'*
- *Some intervention in the classroom i.e. Powerpoint demonstrations shown but most of the intervention has been out of the classroom, raising the awareness of physics and science careers. I.e. displays, assemblies, rocket day, science at work day. Overall impact has been to raise the awareness of physics and careers around school.*
- *Short term fun practicals as hoot? in lesson; pupils engaged in project now running a club for younger pupils; unfortunately impact at this stage is fairly limited-school uptake of physics is very good - 16% of 16+pupils take up physics.*
- *Looking at ensuring pupils can explore the relevance of physics to everyday life.*
- *Dept detailed level consideration of factors and issues raised*
- *Teacher has worked hard to develop resources and has provided feedback to pupils and staff. He has promoted physics across the school and has arranged extracurricular activities to attract girls into the subject and at Post-16.*
- *A positive impact would be to have increasing numbers of pupils opting for physics at post-16. Provisional numbers indicate that there has been a positive input and we are making provisions to run 3 groups of physics in Year 12 next year.*
- *to deliver the physic element(s) of the GCSE courses, vitally important when the teacher(s) is/are not a physics specialist.*
- *Teacher has run after school lessons to encourage the pupils to consider physics at A level. These have also raised the pupils' general feeling towards science as well.*
- *The project has accelerated his understanding and ability to deliver online learning in his classroom. Teacher has shared this with other colleagues in science and across the school, and also with parents.*
- *greater engagement with physics by the pupils because of the strategies employed*

Please expand on your answers to question 8 [*Please indicate the extent to which you feel the teacher's participation in the course has impacted on [a variety of factors]*] if you wish:

- *At present findings have not been fed back formally to colleagues.*
- *I feel it is a little bit too early to evaluate the benefits in terms of A level recruitment, effect across the department*
- *Impact will be more easy to assess after video is completed and shown across West Yorkshire schools.*
- *impacted on the science results*

- *It is really difficult to judge the above - see notes on Q7. The answers to these questions have been based on all projects, not just this one.*
- *Teacher was already confident teaching physics. This intervention has allowed teacher to influence pupils in other classes.*
- *The impact of this course will be visible after the participating teacher has completed it. It will be introduced to the rest of the faculty.*
- *The teacher has whole school responsibilities and intends to use his experience gained during this programme to enhance T&L strategies across the school in professional learning sessions.*
- *There is a possibility that this intervention will be continued in other STEM subjects.*
- *Waiting to see if there is an impact before encouraging other people to do it*

Please elaborate on your answer to Q12 [*Do you have any plans about using your teacher's findings in future staff development?*]:

- *... science department INSET*
- *A case study of an action research project.*
- *Careers in Physics information can be disseminated and shared amongst other teachers to share with future groups of pupils.*
- *CPD for staff after school; SEF*
- *department and science trainees*
- *He has now left.*
- *HoD hasn't taken such on board (not chemistry related?)*
- *I would have a better idea in 12 months time; too early also for answer to usefulness of teacher's participation in course.*
- *It has been good for the teacher to be part of this programme and it has enabled her to develop her physics teaching further, thereby supporting the pupils fully.*
- *It would be useful as an example to encourage other teachers to undertake some action*
- *Once some more information about impact is gathered*
- *Roll out the use of the research to other departments to enhance T&L.*
- *See Q3*
- *Share resources and ideas with other non-specialist physics staff*
- *The participating teacher will lead INSET for the faculty using her 'findings'*
- *The teacher will provide INSET to the faculty at future meetings in order to help staff/pupils more towards A+A* physics at GCSE.*
- *This idea has been discussed in the schools STEM forward thinking group as a possible option before pupils choose their GCSE options.*
- *This work was subject specific*
- *to deliver inset to staff illustrating strategies that could be applicable in their subject area eg The Big Picture, Chunking and PupilVarie(?)*
- *to support other Heads of Department.*
- *We will consider the methods for analysis in other subject. In addition the findings will be discussed at length in a department meeting.*
- *within department*

Please expand and comment on your answer to question 14 if necessary [*Would you send other teachers on the course in the future?*]:

- *Depending on my opinion in 12 months time*
- *I feel the course would have been better if completed in a shorter time frame e.g. 6 months.*
- *I would have to see if the impact on the faculty would warrant further attendance.*
- *if an identified aim could be justified in line with the school improvement plan.*

- *Impact does not justify time away from classes.*
- *It is a very good course.*
- *It would depend on what whole school aims were likely to be met.*
- *Member of staff has been positive about the outcomes.*
- *Only have 1 physics specialist.*
- *There is only 1 physics teacher.*
- *Time allocation off timetable (3 days required)*
- *We have an "excellent teacher" in physics department*
- *We have no physics specialist in the department*

Any other comments:

- *As a CPD manager, I am not fully aware of the consequences of this work. The teacher and/or close colleagues might be better placed to give an accurate judgment.*
- *Completely depends on the professional needs of the teacher.*
- *Enjoyable and worthwhile. Also good can contribute to MA development if desired.*
- *Teacher has enjoyed it and found it very helpful, best CPD he has ever had.*
- *Teacher left school in July - unable to comment on recent impact.*
- *Teacher withdrew from project and left school - no data*

Unable to comment on previous question. I am always pleased when pupils are prepared to stay behind in science, but more specifically in terms of physics I will have a better idea in 12-24 months.