

# Girls Into Physics Action Research

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# *Girls Into Physics: Action Research*

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Centrally involved have been the Science Learning Centre project managers and the teachers who participated in the project. The External Research Team thank the project Steering Group for supporting the evaluation approach and for the experience of working co-operatively on the development of the project. We also especially thank the teachers from the schools who brought their passion for physics teaching and genuine insights to the project and the evaluation.

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External Research Team February 2009

## Executive Summary

*“For me every lesson is a mini action research project. This project has reminded me of the value of risk taking. It is energising, informative, creative and enlightening.”*

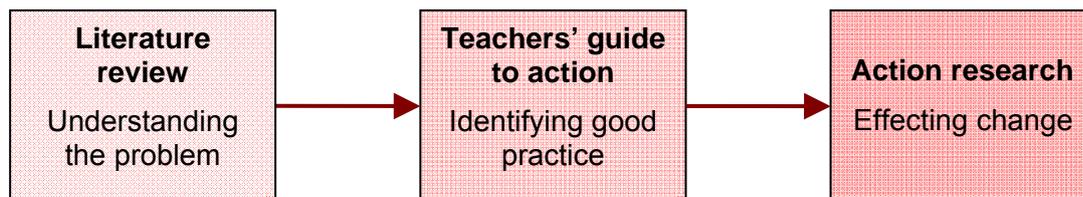
### Introduction

The Girls into Physics programme of work focuses on the persistent problem that girls are under-represented in physics after the age of 16. A substantial number of girls do well at Key Stage 4 but do not choose to study physics post-16. The numbers of physics A level candidates were in decline from 1995 to 2006, but have seen a small year-on-year increase between 2006 and 2008 (IOP, 2008). However, there has been little change in the proportion of girls that have taken the subject post-16. In 2005, 28,119 candidates sat Physics A level. Of these 21,922 (78.0%) were male, making physics the sixth most popular A level subject for boys. For girls, physics was the 19th most common A level choice. In 2005 only 14% of girls who were awarded an A\* or A for GCSE Double Award Science or Physics progressed to A level Physics. In other words, girls are making a conscious choice not to study physics even though they have the ability to succeed in the subject (Hollins et al., 2006: p1). In 2008, the picture was almost identical: 28,096 students sat physics A level and of these 21,941 (78.0%) were male (IOP, 2008).

The Institute of Physics commissioned two studies (known as ‘the red books’) to examine this problem, a literature review on factors that affect girls’ decisions to participate in physics post-16 (Murphy and Whitelegg, 2006) and a review of methodologies that appeared successful in engaging more girls in physics (Hollins et al., 2006).

### Girls into Physics action research with teachers

The Girls into Physics action research programme arose from a desire to work in way that shared information with teachers and supported them to try out strategies that had been identified as successful in the earlier studies. The three elements of the Girls into Physics programme are described in the diagram below:



Initially piloted by the Science Learning Centres in 2006-7, the action research programme with schools was extended, with the help of funding from the Department of Children, Schools and Families, to enable 100 schools to participate in the project in 2008. An evaluation of Phase 2 was commissioned in January 2008. The aim of the evaluation was to gauge the success of the interventions that schools undertook as part of the Girls into Physics project.

## **The evaluation aim and objectives**

The aim of the evaluation was to gauge the success of the interventions that schools undertook as part of the Girls into Physics project. The three objectives of the evaluation are:

- To develop a framework to identify key questions for the evaluation;
- To work with schools and teachers to enable them to measure the impact of the individual interventions in their schools;
- To collect and collate the results from individual schools and produce a synthesis of impact.

## **Synthesis of impact: themes from teachers**

### **Making physics relevant**

*“Make it relevant - to do with people.”*

Teachers tried many approaches to making physics more relevant to girls. Including material on physics careers and careers from physics in class were highly successful in this area, however related challenges were the inability of some students to articulate their careers aspirations and a lack of knowledge about career options among teachers.

Creating opportunities in lessons for students to explore the social relevance of physics (including the roles of physicists) was powerful. Real life experiences with work experience and role models were also effective in ‘bringing physics to life’.

### **Good teaching practice**

*“Be aware of the barrier of language. Use games and communication strategies to get an input into the activities.”*

Interventions were most effective when they built on general good practice in science teaching; in a few cases the gender-specific aspect was given too much priority to the detriment of the overall classroom experience. Interventions in this area related to learning and teaching, and classroom management.

Students were empowered by being able to demonstrate their understanding of a concept using everyday language and structuring groups and assigning roles resulted in fewer interventions to keep students on task.

### **Individualised learning**

*“Independent learning using approaches to enable students to have choices in responses, contexts and approaches.”*

Related to good teaching practice was a smaller theme about individualised learning in physics. Including an element of choice for students in activities helped them feel in control of their learning, however it was important to remain aware that all activities will not suit all students at all times.

## Sharing practice

*“Talk to your colleagues early on about what you are trying to do.”*

Sharing practice within and outside school was a strong success factor for teachers. Involving colleagues at an early stage worked well and some teachers worked with other departments to share learning. Collaboration between specialist and non-specialist teachers also worked well. However the project identified a need for more CPD in gender-aware teaching.

## Action research and changing practice

*“Identify a ‘small’ change in practice as the focus. The key is to make that small change significant.”*

Teachers reflected on the impact of the action research approach. They agreed that small changes in practice that don’t take much time or resource can have a big impact on engagement. Involving students and highlighting student voice greatly enriched the process. Unfortunately the timescale for the project was short and teachers were frustrated at not being able to measure longer-term outcomes.

## Synthesis of impact: themes from researchers

*“The year 10 girls’ focus group was an eye opener to how girls view physics”*

Teachers required time, space and support to place the Girls into Physics literature and pedagogies in the contexts of their own schools and classrooms. Capturing and listening to students’ opinions and voices was a powerful way to inform practice. The wealth of information in the guide for action was overwhelming for some teachers, so support to identify a starting point for change was crucial to success.

The researchers identified three themes as crucial first steps in the process of changing girls’ participation in physics in schools:

- A **consideration of gender equality** in relation to theory, policy and practice will inform teachers in their current practice and have an impact on girls’ participation in physics in the long term. There was not time within the project for an academic consideration of the importance of gender as an equality issue and the persistent inequalities in girls’ participation in physics post-16.
- **Action research** has been an effective way for teachers to access the Institute of Physics ‘Girls into Physics’ materials. This type of learning has to be experiential, where teachers could try out methods for themselves. For many the starting point was very general and the project has been an opportunity to engage with the issues personally and as a school. This led to the development of more meaningful research questions.
- Many teachers reported that they found **pupil voice** to be one of the most informative aspects of the project. The informal and qualitative discussions with girls in particular have had an impact on teachers’ appreciation of the extent of girls’ exclusion. The legacy of this project is that teachers’ have experienced methodologies that help them access pupil voice and value that contribution.

## Conclusion

*“The pre-questionnaire we did on students’ attitudes was a big wake up call to the Department... ..this generated a lot of discussion about how we would tackle this”*

Teachers required time, space and support to place the Girls into Physics literature and pedagogies in the contexts of their own schools and classrooms. Capturing and listening to students’ opinions and voices was a powerful way to inform practice. The wealth of information in the guide for action was overwhelming for some teachers, so support to identify a starting point for change was crucial to success.

## Recommendations

Recommendations have been constructed for three key aspects:

- *Recommendations for teaching practice* - advice aimed specifically at practicing teachers, divided by research cluster;
- *Recommendations for immediate action* - guidance for relevant organisations and individuals outside the classroom;
- *Possible developments of Girls into Physics* - potential areas of future research in the area.

### Recommendations for teachers (from participating teachers)

#### 1. Learning & Teaching

- 1.1. Talk to students to understand the context in your classroom
- 1.2. Get students onside to work with you to change this
- 1.3. Make sure students understand what physics is
- 1.4. Discuss the nature, purpose and relevance of physics

#### 2. Classroom Management

- 2.1. Ensure interventions are appropriately timed
- 2.2. Sharing good practice in school and beyond is valuable

#### 3. Careers

- 3.1. Careers advice should be integrated throughout secondary school
- 3.2. Become aware of students’ career aspirations
- 3.3. Improve access to existing physics-related careers materials
- 3.4. Links to careers should be highlighted throughout normal teaching

#### **4. Progression**

- 4.1. Use appropriate role models at all stages of progression
- 4.2. Link the physics covered to wider social relevance and interest

#### **5. Workforce**

- 5.1. Specialist teachers can work with non-specialists to build their confidence and suggest strategies
- 5.2. Consider the balance of factors that create a good physics teacher and don't prioritise specialist knowledge above all else

#### **6. Culture and ethos**

- 6.1. Use interventions that the whole school can see or get involved in

#### **Recommendations for stakeholders** (developed from the wider experience of the project)

7. Two-day programme model should be continued as it was well received by teachers and ensured their deeper involvement.
8. Appropriate application of the Red Books can inform teachers of previous research and best practice, but it is crucial that the data and methodologies contained within are not followed blindly.
9. Gender aware teaching should be incorporated into standard CPD

#### **Recommendations for future research** (developed from the wider experience of the project)

10. Develop the third phase of Girls into Physics learning from this report and incorporating greater levels of student involvement, more appropriate timing, short and simple action research projects and follow-up with phase two teachers.
11. Commission a research and practice briefing dealing with the specific issue of single sex groupings and physics
12. Analyse the longer-term impacts of the project by reviewing selected schools in four years' time

# 1. Introduction

## 1.1 Background

The Girls into Physics programme of work by the Institute of Physics focuses on the persistent problem that girls are under-represented in physics after the age of 16. A substantial number of girls do well at Key Stage 4 but do not choose to study physics post-16 (Hollins et al., 2006).

The numbers of physics A level candidates were in decline from 1995 to 2006, but have seen a small year-on-year increase between 2006 and 2008 (IOP, 2008). However, there has been little change in the proportion of girls that have taken the subject post-16. In 2005, 28,119 candidates sat Physics A level. Of these 21,922 (78.0%) were male, making physics the sixth most popular A level subject for boys. For girls, physics was the 19th most common A level choice. In 2005 only 14% of girls who were awarded an A\* or A for GCSE Double Award Science or Physics progressed to A level Physics. In other words, girls are making a conscious choice not to study physics even though they have the ability to succeed in the subject (Hollins et al., 2006: p1). In 2008, the picture was almost identical: 28,096 students sat physics A level and of these 21,941 (78.0%) were male (IOP, 2008).

## 1.2 The Girls into Physics programme

In 2004, the Institute of Physics commissioned two reviews to investigate the reasons why girls choose not to progress to post-16 physics and to explore what kind of teaching and learning strategies support girls who do proceed. These two publications became known in the project as the Girls into Physics 'red books'.

Murphy and Whitelegg's (2006) review of the literature in this area identified three key factors that influenced girls' decisions about studying physics. These are physics 'self-concept', views of physics and physics teaching. Physics 'self-concept' includes girls' perceptions of the relevance of physics to them and their futures, which are linked to their feelings of competence (or lack thereof). Ponchaud's review (Hollins et al., 2006) identified seven aspects of effective classroom practice observed in schools where the take up of physics by girls is relatively successful. The areas were school culture and ethos, curriculum and organisation, classroom management, questions and answers, the use of language, the use of analogy and illustration and relevance.

As the Girls into Physics programme has evolved, a series of resources<sup>1</sup> have become available to the science teaching community that build understanding of how teaching and learning strategies based on gender research can be used to engage girls with physics. The action research<sup>2</sup> approach adopted within this programme arose from a desire to work in way that shared this information with teachers and supported them to try out strategies that had been identified as successful in the earlier studies. Initially piloted by the Science Learning Centres in 2006-7, the action research programme with schools was extended, with the help of funding from the Department of Children, Schools and Families, to enable 100 schools to participate in the project in 2008.

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<sup>1</sup> Girls into Physics resources are available from the Institute of Physics [www.iop.org](http://www.iop.org)

<sup>2</sup> Various definitions of action research were discussed in the workshops, for example: . [Action research] brings together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people (adapted from Reason and Bradbury, 2006).

Outputs from the Girls into Physics programme of work to date include:

- Girls in the Physics Classroom Research - known the 'Red Books'
  - Murphy, P. and Whitelegg, E. (2006) *Girls in the Physics Classroom: A Review of the Research on the Participation of Girls in Physics*. London, Institute of Physics
  - Hollins, M., Murphy, P., Ponchaud, B. and Whitelegg, E. (2006) *Girls in the Physics Classroom: A Teachers' Guide for Action*. London, Institute of Physics
- Girls into Physics Videos
  - "Saving Nellie" a drama produced by the Institute of Physics
  - "Key Stage 3/4 Science: Girls into Physics" Documentary produced by Teachers TV
- Girls into Physics Action Research with schools
  - Pilot 'Girls into Physics' 2007 with NSLC/regional SLCs
  - Extended project (Phase 2) 'Girls into Physics: Action Research' 2008

### **1.3 Girls into Physics: Action Research (Phase 2)**

Phase 2 of the Girls into Physics programme initially involved working with 101<sup>3</sup> schools across the UK. Of these, teachers from 59 schools completed the project and submitted final reports. A full list of schools that reported in this phase is contained in Appendix 1.

The Science Learning Centres were commissioned to recruit the schools and to work with teachers to review participation of girls in physics in their own schools. The SLCs then worked with teachers to develop action research projects to address the issues identified. Drawing on the best practice review (Hollins et al., 2006), it was anticipated that the research projects would fall into the following clusters:

- *School Culture*: whole school ethos and support from senior management;
- *Teaching and learning strategies*: shaping physics curricula and pedagogies to be more relevant and inclusive;
- *Classroom management*: using mixed and/or single gender groups within lessons;
- *Careers education and guidance*: strategies for teachers and IAG specialists or providing careers-focussed teaching and learning strategies;
- *Progression*: exposing girls to more pathways for studying physics;
- *Workforce*: exposing more pupils to specialist physics teaching.

---

<sup>3</sup> The National Science Learning Centre recruited 13 schools in 2007 who conducted action research projects prior to the involvement of the External Research Team. This data has been included within this report, although note that the reporting format was slightly different. The regional Science Learning Centres recruited 88 schools in total in January 2008, making a total of 101 schools at the beginning of Phase 2.

## **1.4 Evaluation aim and objectives**

An evaluation of Phase 2 was commissioned in January 2008. The aim of the evaluation was to gauge the success of the interventions that schools undertook as part of the Girls into Physics project. The three objectives of the evaluation were:

- To develop a framework to identify key questions for the evaluation;
- To work with schools and teachers to enable them to measure the impact of the individual interventions in their schools;
- To collect and collate the results from individual schools and produce a synthesis of impact.

## **1.5 The role of the External Research Team**

The External Research Team consisted of a consortium of educators in the fields of widening participation, science communication and gender education, based at three separate institutions around the UK.

### ***Lead Researchers***

Angie Daly, Widening Participation Research Centre, Edge Hill University  
Dr Laura Grant, Laura Grant Associates  
Dr Karen Bultitude, Science Communication Unit at the University of the West of England, Bristol

### ***Advisory role***

Professor Liz Thomas, Professor Martin Ashley at Edge Hill University

## 2. From 'red books' to a Theory of Change

A framework for analysis was designed to locate the teachers' prospective action research projects in the context of the key messages from the Girls into Physics 'red books'. The framework developed by the External Research Team used a Theory of Change model<sup>4</sup> which explained the literature and practice in three inter-connected layers:

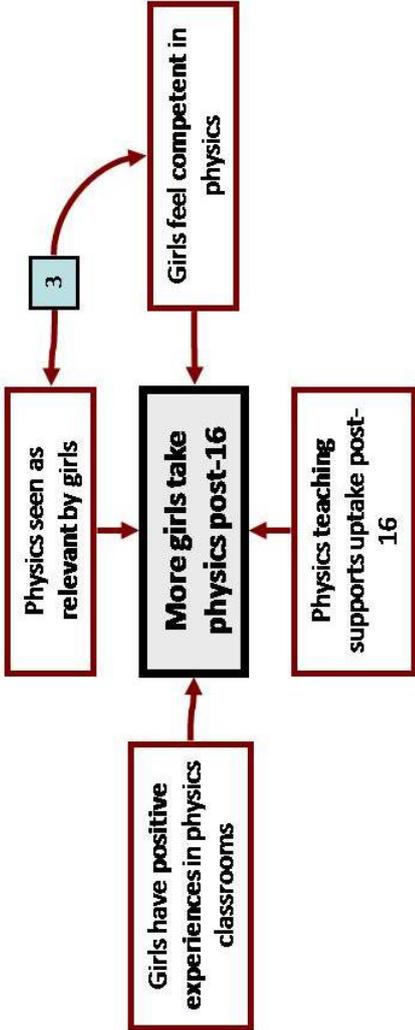
- Influential factors on girls' decisions to participate in physics;
- Essential practice that supports girls' participation in physics;
- Effective pedagogies to support girls' (and boys') engagement with and understanding of physics

(See Figures 1, 2, 3)

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<sup>4</sup> For more information on developing a Theory of Change see [www.theoryofchange.org](http://www.theoryofchange.org); Chen (1990); Chen and Rossi (1992).

Figure 1 - Influential factors on girls' decisions to participate in physics

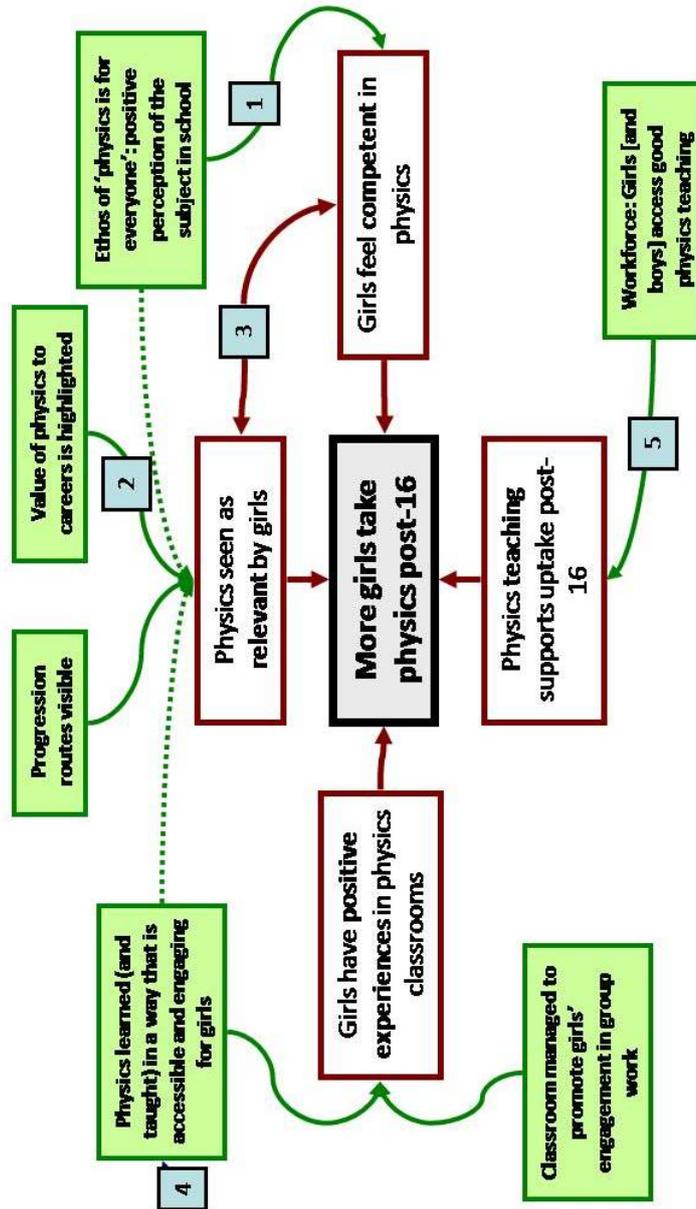


- Assumptions**
1. Girls less likely than boys to feel competent in physics
  2. Girls more likely to link subjects with careers than boys
  3. Perceived relevance linked to feelings of competence
  4. Girls more interested than boys in social contexts and how physics can help people
  5. Girls more vulnerable to poor physics teaching than boys

**Girls into Physics  
Action Research**

**Theory of Change**  
**Influential factors on decisions**

Figure 2 - Essential practice that supports girls' participation in physics

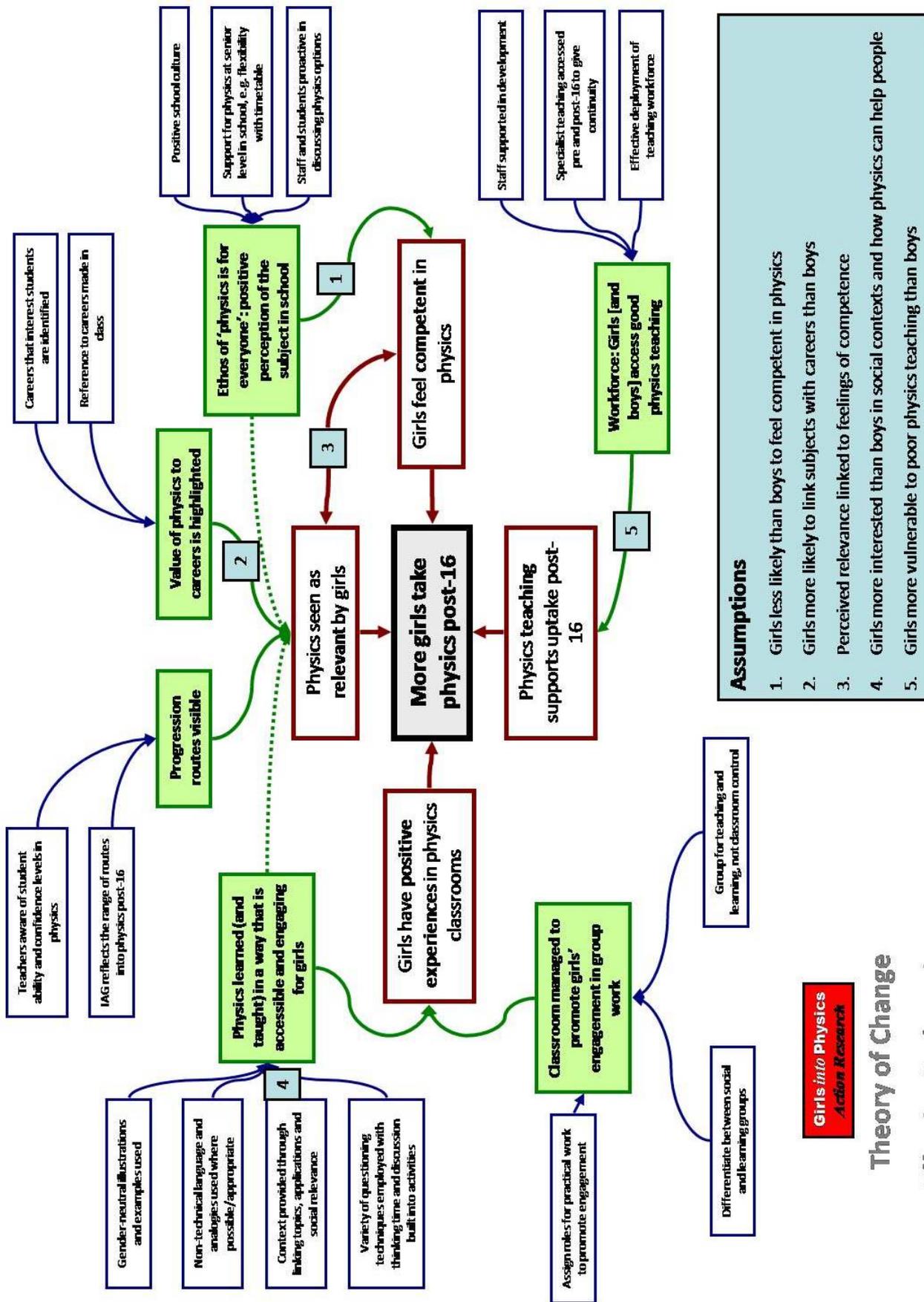


- Assumptions**
1. Girls less likely than boys to feel competent in physics
  2. Girls more likely to link subjects with careers than boys
  3. Perceived relevance linked to feelings of competence
  4. Girls more interested than boys in social contexts and how physics can help people
  5. Girls more vulnerable to poor physics teaching than boys



Theory of Change  
Essential practice

Figure 3 - Effective pedagogies to support girls (and boys) engagement with and understanding of physics



**Girls into Physics**  
Action Research

**Theory of Change**  
**Effective Pedagogies**

## **2.1 Refining the research questions**

The Theory of Change was blended with the six research clusters identified in order to refine the evaluation research questions:

### **Learning and Teaching**

- How are teaching and learning strategies based on gender research being used to engage girls with physics?

### **Classroom Management**

- How can the classroom be managed to promote girls' engagement in physics lessons?

### **School Culture**

- How are schools promoting a positive culture in relation to physics, and what are the mechanisms for effecting culture change?

### **Careers education and guidance**

- How can careers to which girls aspire be included in physics lessons?

### **Progression**

- How have schools implemented successful strategies to support girls in choosing physics post-16?

### **Workforce**

- How are schools deploying and developing their workforce to help increase uptake in physics?

## **2.2 Mapping the Girls into Physics action research projects**

Finally, the Phase 2 Girls into Physics action research projects were mapped onto the Theory of Change. This process located the participating teachers' work in the literature and good practice. The 59 projects which reported back in Phase 2 were mapped onto the research clusters according to each project's identified primary focus (see Figure 4).

An anonymised list of the final allocations of projects into their respective clusters (including secondary and tertiary clusters where appropriate) is provided in Appendix 2. A brief summary for each project (written by the teacher involved and ordered by research cluster) is provided in Appendix 3.

Figure 4 - Mapping of action research projects

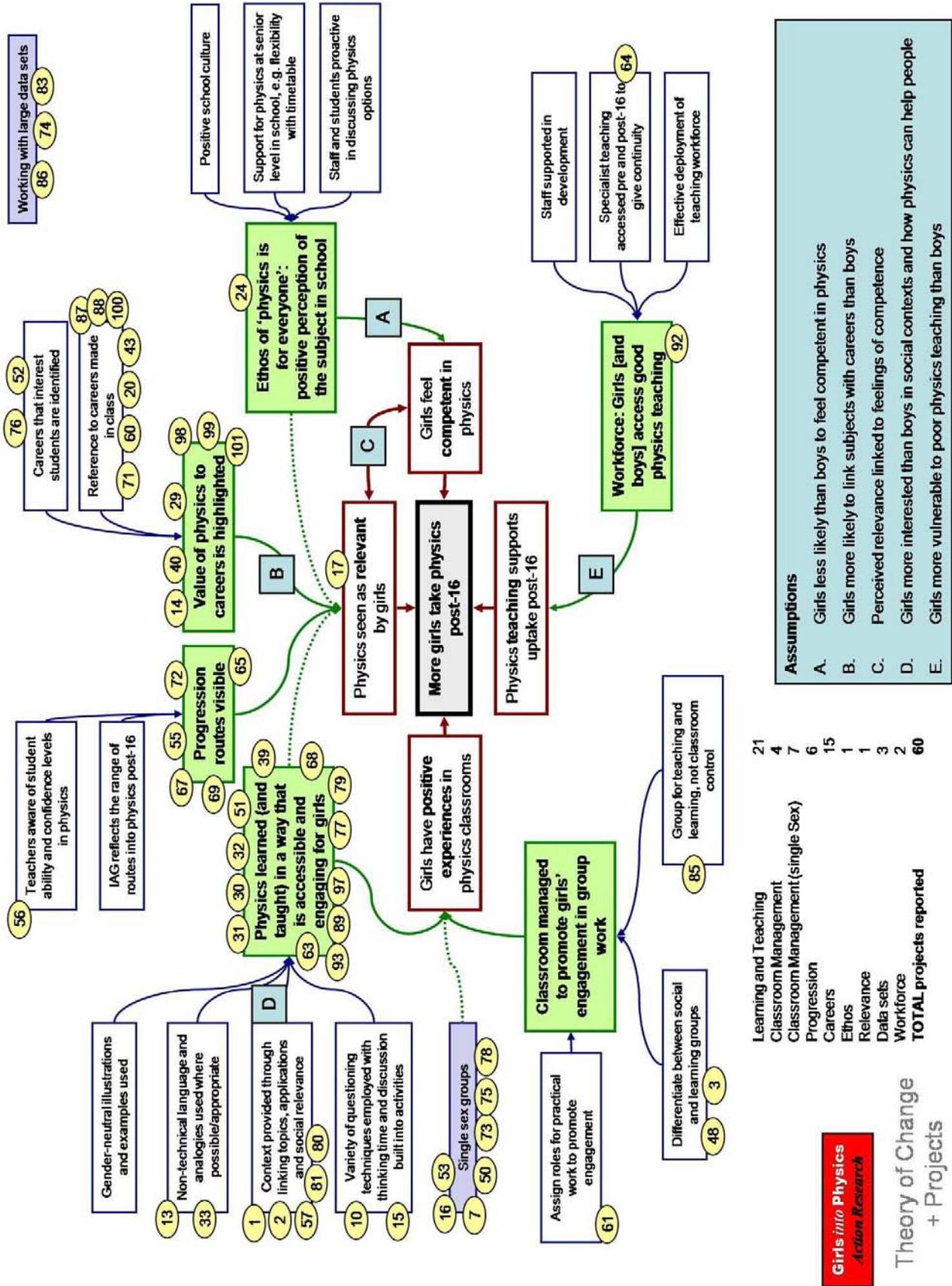
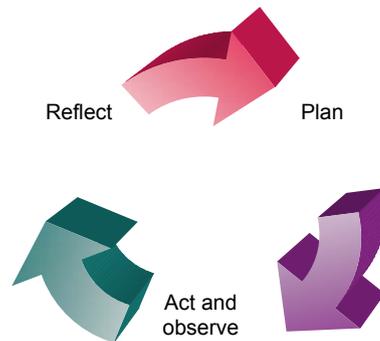


Figure 4 demonstrates the spread of the projects across the cluster areas. Note that three projects chose to work with large data sets (looking at school data) and had not applied an intervention at reporting stage. Some of the projects focussed on Classroom Management, choosing to divide students into single sex groups. This action was not promoted as part of the project and findings in this area will be discussed more fully in Section 5.2, Classroom Management.

### 3. Research and development: supporting teachers' action research

The approaches to action research discussed at the workshops stressed the importance of thinking through the research as a cyclical process, as outlined in Figure 5. This cycle involves related stages of reflection, planning, action and observation leading to further reflection and planning (McNiff et al., 1996).

**Figure 5: Stages in the action research process**



The teachers' involvement consisted of attendance at two workshops (for planning and reporting respectively) with a period of approximately six months in between in order to perform the action research. Separate workshops were held at each participating Science Learning Centre, usually jointly delivered by local SLC staff and a member of the External Research Team. The participating teachers were supported via email and / or phone during the intervening action research period.

#### 3.1 Project resources

Various resources were developed to support the project, including:

- Research Questions (see Section 2.1)
- Theory of Change (see Section 2)
- Indicators Toolkit (see Appendix 4)

##### 3.1.1 Young Researchers

Many activities aiming to widen participation in education target young people, but these young people rarely have any opportunities to shape these programmes or give their opinions. For example, Gillbourn and Youdell (2000) summed this up by saying *“pupils are clearly positioned as the subject of numerous organisational and disciplinary discourses in which the young people themselves play little active role.”*

The External Research Team's experience of working with young researchers in previous projects identified that young people's contributions are invaluable to research, although their involvement frequently required a high level of support. For this reason it was agreed that only schools that had been involved in Phase 1 of the Girls into Physics project would be invited to include young researchers, on the premise that the teachers involved must be willing to support them. Five of the Phase 2 schools included young researchers, who had

roles such as consultative participants, designers of interventions and peer educators. Their views are reflected in this report.

### **3.1.2 Community area on the science learning centre portal**

A Girls into Physics community area on the Science Learning Centres portal<sup>5</sup> was used to store resources and outputs from Phase 2 and to share materials and learning amongst the ~120 people involved in the project.

## **3.2 Action research planning workshops**

The first series of workshops focussed on providing teachers with the skills and resources to plan their own action research projects. Separate workshops were held at each of the participating regional Science Learning Centres during Spring 2008. The aims of the initial planning workshops were to:

- Introduce and discuss the existing Girls into Physics research and resources;
- Support teachers to identify the key issues arising from the literature and practice reviews;
- Enable teachers to reflect on these key issues in relation to their own practice and school practice;
- To allow each teacher to design an action research project and intervention based on gender aware physics teaching;
- An outline of the suggested schedule for the planning workshops is provided in Appendix 5. Supporting resources developed for use by teachers at the planning workshops included a self-evaluation questionnaire (see Appendix 6) and an action research planning template (see Appendix 7).

## **3.3 Action research reporting workshops**

The second series of workshops focussed on providing participating teachers with an opportunity to share their experiences and learn from each other's action research interventions. Again, separate workshops were held in each of the participating regional Science Learning Centres during Autumn 2008. The aims of the reporting workshops were to:

- Share experiences and learning with other teachers;
- Build teacher confidence and appreciation of their involvement in the Girls into Physics project;
- Stimulate further work, both in terms of teaching and action research;
- Identify outcomes for the action research project and reflect upon them;

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<sup>5</sup> [www.sciencelearningcentres.org.uk](http://www.sciencelearningcentres.org.uk)

An outline of the suggested schedule for the planning workshops is provided in Appendix 8, whilst the teacher preparation instructions are available in Appendix 9. Supporting resources developed for use by teachers at the reporting workshops included an action research reporting template (see Appendix 10).

### **3.4 Research methods used by teachers**

Specific advice provided to teachers during the planning phase included:

- Stay small, stay focused;
- Identify a clear research question e.g. “How do I...?”
- Be realistic about what you can do; also be aware that wider change begins with you;
- Plan carefully;
- Set a realistic timescale;
- Involve others - as fellow researchers, as observers;
- Ensure good ethical practice;
- Concentrate on learning, not on the outcomes of action.

As expected from a wide and diverse cohort of participants, the teachers involved in Phase 2 of Girls into Physics progressed through this cycle in a variety of different ways.

*Reflection* - Teachers approached the project from a range of different starting points, including:

- Reflection on their own teaching practice;
- Peer and student observations of teaching;
- Focus group discussions with girls, for example about attitudes to physics, responses to physics teaching, perceived relevance of physics;
- Questionnaires distributed to students on attitudes to science in particular and physics in general;
- Discussions with colleagues in departments;
- Gathering of large quantitative data sets showing trends.

*Planning* - Teachers applied the information gathered during the reflection stage in different ways, for example:

- The consultation or gathering of data became the extent of the project;
- Initial ideas were altered on basis of reflection, for example realistic timing, scope, size, research cluster;
- An appropriate action relating to the potential impact on an issue was identified;

- An action was pursued which was judged capable of being carried out, taking into account confidence, fit with curriculum topic and timetable;
- Potential support from colleagues identified;
- Potential support from students identified.

*Act and observe* - Teachers had varying experiences with observations/data

- Large quantitative data sets were useful background information but too large to inform a small scale action research project;
- Qualitative data collection proved the most informative for action research planning and reflection on action;
- Projects varied in size and scope, some were not manageable within the timeframe of this project;
- Project outcomes which could be shared with students and colleagues supported analysis and planning for next steps.

## 4. Profiles of participating schools

### 4.1 Electronic survey

Schools were asked to complete an e-survey to gather information on the broad characteristics of schools involved in the project. This included information relevant to widening participation in Higher Education, attainment and progression in physics and the background of teachers involved in the project. The information gathered for this survey was intended to be useful to teachers to help them contextualise their own action research projects. Findings are reported in full in Appendix 11, along with an outline of each of the questions asked within the e-survey. 33 teachers completed the survey, from which the key findings are:

#### About schools

- The Girls into Physics project features more strongly in individual and department development plans (focussing on improving quality of teaching) than in whole school development plans (focussing mainly on increasing uptake of post-16 science provision and/or increased attainment);
- Schools are or have been involved in a variety of additional aspiration raising activities that support girls' participation in physics. These include a large number (22) involved in Aimhigher activities with a science / physics element. Other aspiration raising activities include STEM (5) Stimulating Physics (3), Engineering in Education (2), Physics Olympiad (2), Building Schools for the Future (1), Encouraging Pupils in Science KS4 (1), University linkages (1) and the Institute of Physics Paperclip Physics (1);
- Enrichment activities with a specific physics dimension are organised by many schools, for example science, engineering, physics and astronomy clubs, including one science and engineering club for parents. Links with other initiatives and organisations include National Science Week, various universities, local industries and Women into Science and Engineering (WISE);
- Information regarding numbers and destination of progression to HE is not readily available to all teachers. Anecdotal responses indicated that issues relating to progression included: students are unsure about the difference between Physics, Biology and Chemistry for post-16 study; applied science is not accepted as a science subject at local colleges; and that physics is perceived to be, and experienced as, too hard at AS level. For some schools, while overall progression to HE is good or improving, very few are progressing to Physics related courses at HE and students perhaps do not see it as a relevant subject.

#### About physics teaching in schools

- At Key Stage 3, curricula offered within participating schools included Exploring Science, QCA scheme of work, OCR 21<sup>st</sup> Century Science, Triple Science, Hodder Science and Spotlight Science. One school offered its own School Science curriculum combining Physics and Chemistry and one school offered Year 9 BTEC Science (EdExcel);
- The time allocation for the Science curriculum within the KS3 timetable ranged between 7% and 25%.

- At Key Stage 4, curricula offered within participating schools included OCR 21<sup>st</sup> Century Science, Electronics, EdExcel 360 Science, AQA Science, Gateway, BTEC Science (EdExcel) Year 9 and 10, Applied Science, Additional Science, Single Science, Science Double Award and Science Triple Award;
- The time allocation for the Science curriculum within the KS4 timetable ranged from 7.5% to 25%;
- The delivery of physics teaching within the curriculum was organised in different ways amongst the participating schools. Some schools (7) included identifiable separate Science subjects throughout, using distinguishable topics and/or teachers for the different sciences. More schools (10) organised KS3 as general science, with separate subjects and specialist teachers at KS4. Three schools organised science teaching into ability sets at KS3. Six schools ensured specialist physics teachers teach at Year 11 and 12, with two schools using specialist physics teachers from Year 9.

### **About teachers of physics in schools**

Teachers were not always able to access information about colleagues' qualifications, previous experiences and training. The information below is a snapshot of the anecdotal data provided.

- Teachers' physics related qualifications ranged from PhD (2), MSc including MPhys and MEng (8), Physics BSc (25), BEd Physics (3) and PGCE (4). In addition there were many participating teachers who were not physics specialists. 4 teachers had physics qualifications gained through inset and CPD for the teaching of physics. 3 teachers had A level physics and 1 A level chemistry whilst 3 teachers had GCSE double award science;
- Many teachers had additional experiences from engineering and industry that may be relevant to science and physics teaching, including design and build, research and development (12), Medical / NHS including science technician and health professional (5), Scientific research including academic research posts and PhD research (7), Careers (1) and other including youth work (3).

### **4.2 Report on DCSF Girls into Physics data**

An analysis of the data on all schools in England provided by DCSF was conducted. The full data set and analysis, including charts outlining demographic details, are provided in Appendix 12. In summary:

- The Girls into Physics project sample (from the 59 schools that completed the project) includes mainly Comprehensive schools (91%) with 11-18 or 11-16 intake (60% and 33% respectively);
- Science specialist schools, were over-represented compared to the national and regional picture (20% compared to 7% and 7% respectively);
- Specialist schools with a non-science specialism were also over-represented (73% compared to 56% in participating regions and 55% nationally)
- No boys' schools participated in the project;

- The participating schools had fewer students eligible for free school meals (around 7%) than the national and regional averages (8.9% and 10.7% respectively), although the difference is less marked for schools that completed the project (7.4%) as opposed to the full cohort who attended the first planning workshop (6.7%);
- White British students are over-represented in participating schools compared to the average regional distributions (87% compared with 85%). There is even greater diversity in the national data set, where 79% of students were of White British origin, probably because the London region was not targeted for this project;
- On average, participating schools outperform the national and regional averages at KS3 and KS4, however the value-added scores are in line with regional averages (see Appendix 12 for detailed breakdown);
- The Level 3 attainment for schools who attended the first planning workshop is slightly lower than the national average, although the average for schools that completed the project is slightly higher than the national average (see Appendix 12 for detailed breakdown);
- Schools with higher attainment at levels 1 (Key Stage 3), 2 (GCSEs) and 3 (A levels and equivalent) were more likely to complete the project (see Appendix 12 for detailed breakdown).

## 5. Findings from the Research Clusters

This section provides an overview of the evaluation findings. The results are grouped according to the six research clusters identified in Section 1.3. Each cluster begins with a brief summary of the key literature findings, as well as an overview of the participating teachers' practice at the start of the project related to that research cluster. A summary of the action research projects within the cluster is provided, as well as an outline of teachers' experiences during their interventions. Both of these elements are grouped according to the 'effective pedagogies' identified within the Theory of Change (see **Figure 3** and Figure 4). Finally, the key areas of impact which were identified for that cluster as part of this project are detailed.

### 5.1 Learning and Teaching

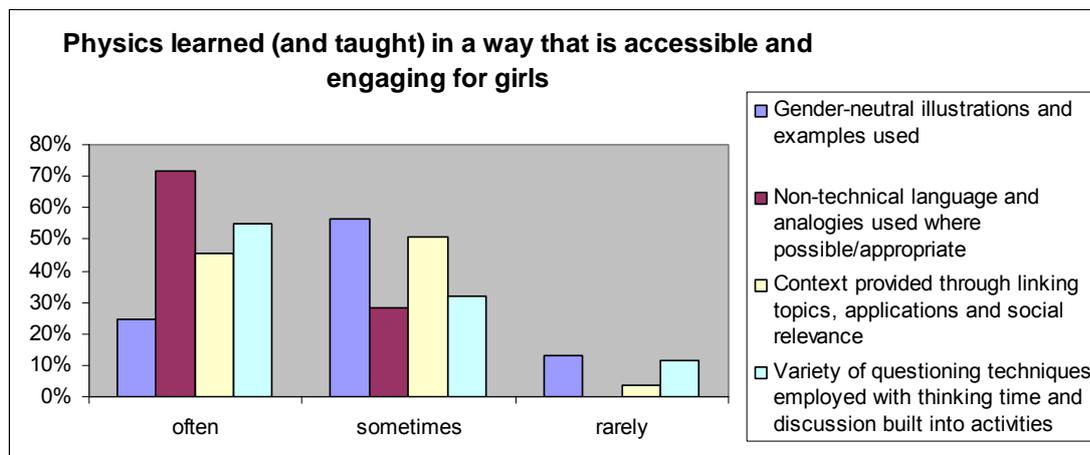
#### ***How are teaching and learning strategies based on gender research being used to engage girls with physics?***

Gender research into physics learning and teaching has shown girls respond better to physics when they can see a human-related application, whereas abstract concepts are generally more popular with boys (Stadler et al., 2000). However, approaches to teaching physics with an emphasis on physics as a socially relevant and applied subject has led to higher attainment for both males and females (Murphy and Whitelegg, 2006). Physics teaching is often 'application free', involving the understanding of abstract concepts, yet the relevance of physics as a subject for human development, society and in the workplace is key to successful gender aware curriculum and approaches to teaching physics (Mottier, 1987). The importance of gender equality in learning and teaching is crucial not only to engage more girls in physics but also to improve understanding and achievement for both boys and girls.

Pedagogies that support gender aware teaching and learning of physics and ensure that physics is learned (and taught) in a way that is accessible and engaging for girls (Murphy and Whitelegg, 2006; Hollins et.al., 2006) were used by the participating teachers as a basis for planning their action research projects. Previously identified successful strategies include using:

- Gender-neutral illustrations and examples;
- Non-technical language and analogies;
- Context through linking topics, applications and social relevance;
- A variety of questioning techniques employed with thinking time and discussion built into activities.

**Figure 5 - Teacher self-evaluation responses to learning and teaching at start of project**



Teachers were generally fairly confident that they already ‘often’ incorporated the teaching practices included within this cluster. Both ‘non-technical language & analogies’ and a ‘variety of questioning techniques’ were employed ‘often’ by a majority of teachers (72% and 55% respectively), and 45% placed physics in context. However 57% of teachers admitted to incorporating ‘gender-neutral illustrations & examples’ only ‘sometimes’, and 13% ‘rarely’.

### 5.1.1 The action research projects

Teaching practice is an area that teachers have a high level of control over, so arguably this might be expected as a popular starting point. Twenty one schools had Learning and Teaching as a primary focus for their action research projects. A further five chose this as a secondary focus. The projects relevant to this cluster are provided in the box below.

<b>Teaching and Learning action research projects</b>
<p><b>Working with gender-neutral illustrations and examples [1 project]</b> One teacher investigated the impact of different types of examples used in class.</p>
<p><b>Using non-technical language and analogies [3 projects]</b> Interventions included students developing their own analogies for science topics, creating more engaging lesson starters and using new media.</p>
<p><b>Providing context through linking topics, applications and social relevance of physics [10 projects]</b> Projects included developing schemes of work collectively; linking teaching and learning strategies from other subject areas e.g. drama and biology; and working with colleagues in careers to locate physics in the real world. An additional area of teachers’ experiences emerged focussed on practical sessions and a greater degree of hands-on exciting demonstrations.</p>
<p><b>Developing questioning techniques, thinking time and discussion [7 projects]</b> Interventions included using whiteboards and / or electronic voting for the class to answer questions simultaneously and group discussion and feedback via a spokesperson which helped to identify misconceptions in class without singling out learners who don’t understand.</p>

## 5.1.2 Teachers' experiences

### Working with gender-neutral illustrations and examples

The difference between gender specific and gender neutral examples appeared to be confusing to many teachers. One teacher investigated the impact of different types of examples used in class: gender specific (Ronaldo Vs a Bugatti), non gender specific (superhero jumping off a building) and old school (ticker tape, graphs etc.) examples. The findings (where the girls in the class responded best to the ostensibly male-oriented but more 'real-life' footballer/car example) were somewhat surprising to the teacher involved:

*"Gender specific example does not make a difference to confidence of pupils answering questions. Concluded that girls respond better to the real life situation rather than conceptual process" [GiP68]*

### Using non-technical language and analogies

Teachers tackled the barrier of technical language to students' understanding of physics by introducing new topics first by using non-technical language, followed by providing clear definitions related to technical language. Establishing a 'picture' of a concept before introducing equations and new terminology was found to be useful for both boys and girls. For some this included developing a series of starter activities which built the context of the learning and set a challenge for pupils to consider prior to learning the content which was then used to solve the challenge.

Starter activities were thought to be a problem by one teacher who thought "...*the current starters to lessons were lacking interest and had become more of a routine*". He decided to challenge the class to come up with some more interesting starters, which were used in subsequent lessons. Questionnaires for the whole class and feedback from a focus group of girls before and after the intervention helped him measure the success of this approach. Students didn't find the new starters much more informative than the old ones, but there was a dramatic increase in whether the starters made them want to learn more about the subject, perhaps because they were developed by the students themselves. This positive impact was true for both girls and boys.

*"The research showed that a good starter encouraged boys and girls equally to want to learn more. The department have decided to produce a bank of more imaginative ideas to be used to introduce lessons... The effect of using starters with more impact from a bank of more imaginative ideas should be long term" [GiP39]*

### **Case study: Analogies [GiP13]**

*"I like analogies and use them a lot in my teaching, particularly as a starter activity. So this was the idea for my action research project. To say to the students 'this is the science - now come up with an analogy of your own'. I wanted to get the students to have a chance to get involved in developing starters for the class, something different to responding to me all the time. I worked with a class of Year 10 and Year 11. I gave them a choice of science problem to describe, resistance and electricity, static electricity, heat transfer or one problem of their own choice. They could work together or work separately. They had to think about an analogy to describe the science and record it in a drawing or in writing and share with the class.*

*What I found was that the young people displayed very high order thinking in how they expressed their ideas and related them to the concepts of physics. I believe it showed up the young people's understanding, not just recall of facts. Using analogies and especially their own ideas appears to be a 'way of seeing' that kids understand. And even if the young people were not that creative in their analogy, you could see what they were getting at in terms of the concepts. However a note of caution, for some young people they could only see the science and couldn't do the analogy at all. This is an important point as I feel with teaching it is important to vary types of activities as not all students respond to learning in the same way. But even if they could not do the analogy themselves they could understand the science behind what other students were describing.*

*In conclusion then, this activity of asking young people to develop their own analogies is useful for some of the class, but doesn't suit all. A positive aspect about the activity was that it didn't depend on gender (both boys and girls participated) or on ability (it seemed to suit all abilities). For some students it had a big impact on their confidence, they came out of their shell and did something they hadn't done before. Something imaginative and also they got the science!*

One intervention involved adjusting a Physics case study to a podcast presentation with the title "Physics is the most important subject taught in school because it has had the most beneficial effect on mankind! Discuss". Other teachers revised the scheme of work to contain YouTube clips from Top Gear and clip bank.

### **Providing context through linking topics, applications and social relevance of physics**

Projects ideas were developed as a result of students' responses to questionnaires and focus groups as well as ideas from colleagues. One department invited peer observations from colleagues to get a feel for how students were responding to different types of teaching in class. They began to work together on joint planning of schemes of work and sharing of resources which has resulted in "a more cohesive department."

Learning from other disciplines has proven beneficial in helping students engage with physics concepts in a fun and relevant way. Examples included working with drama approaches, enrichment activities and revision clubs. One teacher specifically wanted to try out activities to increase enjoyment of physics and has set up a Science Club to promote an approach that locates physics in the real world. Working with the Careers Club they have developed interventions that especially profile women scientists at work and have female guest speakers coming into school.

Another project built on the fact that many students preferred Biology to Physics. The teacher involved developed a set of activities around 'refraction', with one Year 7 class receiving the normal scheme of work lesson and the other Year 7 taught from the biologically relevant starting point of how the eye works. Even though the data for improvement in test scores was limited the teacher is using findings in the next stage of research and for now concludes:

*"Girls enjoy and think they understand Biology unit more than Physics. Kids love dissection! This doesn't mean it was a better Physics lesson. The data isn't enough to prove a significant improvement in attainment. But it's a start!!"* [GiP79]

Many teachers focussed on practical sessions, in particular involving more hands-on exciting demonstrations. Many of these used examples from the Teachers Guide to Action (Hollins et al., 2006) and incorporated other methods to ensure all students could participate in the class. Practical sessions are popular with students and teachers alike (SCORE, 2008). One of the teachers reported that the Girls into Physics project has succeeded in allowing participating teachers more time to focus on delivering and evaluating a variety of well planned activities in the context of busy timetables, where practical sessions can be sometime be squeezed out.

One project that focused on practical lessons highlighted two main factors reported by girls regarding their experience of physics:

*"- old, dirty and broken equipment (this was the most polite version!)"*

*- too much answering mathematical problems rather than doing experiments."* [GiP51]

The subsequent intervention involved buying new equipment for practical sessions and ensuring that the girls had priority for the use of the equipment. This had a positive impact on all the students and especially the girls, who said that they enjoyed the new practical work and in addition they found the work easier to understand:

*"As well as looking good, the equipment allows for precision and accuracy, it works and the students get results. For the students this is a positive learning experience. I hope to be able to use this to stress that practical work is actually central to science learning."* [GiP51]

### **Developing questioning techniques, thinking time and discussion**

Interventions that involved a variety of questioning techniques with thinking time and discussion built into activities demonstrated willingness on the part of the teachers involved to reflect and change their own personal teaching styles.

*"What I tried to do was step back and let them take control and devise progress through the sessions according to their own needs. Of course I still had a structure to the lesson, a starter activity, the main topic and a plenary. In addition, I had developed a topic booklet which contained key information on the topic, questions and comprehension exercises for further understanding. This was reassurance for them and formed the basis of homework. But what we were doing in class was personalised learning, offered choice to the students and an opportunity for students to share and discuss their findings with other groups."* [GiP10]

Another investigation was conducted into whether the style of lesson affects access to information and confidence. Lessons styles used were independent research, investigation, peer teaching, experimental and traditional teaching with demonstrations. Students reported learning best when information was put forward in a variety of ways and when the scientific information was relevant to everyday life. Student confidence was reportedly enhanced

through a greater degree of personalised learning and increasing opportunities to carry out experimental work, either teacher led or independently.

Several of the projects included interventions that promoted greater discussion and reflective time for students to respond in a more measured way, including changing from hands-up questioning to focus on confidence building and encouragement within teaching practice, for example through valuing and developing girls' responses. One teacher introduced new workbooks for Key Stage 4 groups which contained a style of question which remained challenging in places but more closely reflected the style of question in the exam paper. Others promoted discussion by using fewer demonstrations and more problem solving practicals.

*"I felt that lessons that encouraged them to 'do' How Science Works by practical work or discussion promoted more interest and engagement than just information."* [GiP88]

### **5.1.3 Cluster outcomes**

Three key areas of impact on learning and teaching have been drawn from the teachers' documentation of their projects, discussions with teachers and students during the regional workshops, and additional materials teachers have uploaded onto the community area of the Science Learning Centres portal. Each of these areas of impact is described in detail below.

#### **Sustainable change in teaching practice enhanced by the action research process**

A striking result from this cluster is that many teachers said that the project has led to a sustainable change in their practice. The reflections of teachers demonstrate that trying out new approaches and teaching strategies within an action research context has allowed them to reflect on their own practice:

*"The way that I think about teaching physics has already changed - I try to plan lessons in a very different way now - thinking about how to link what we are learning to the students' lives and how to make concepts accessible without automatically throwing equations at them. So I'd say it is very sustainable because it has fundamentally changed the way that I plan and teach."* [GiP15]

*"The change that has occurred in my teaching - that is, being aware of my use of language throughout a topic - will continue as I have seen positive benefits in my classes"* [GiP33]

Some of the teachers concluded that using and researching teaching and learning strategies to make physics specifically more accessible to girls doesn't have a detrimental effect on boys' interests and achievement, but is in fact good teaching practice.

For some teachers the project tied in with broader pedagogical research at their own schools such as action research networks, drama across the curriculum and enrichment activities. For others it was focussed on personal practice, recognising barriers to learning, trying out something in a different way and reflecting on the outcomes. For many this was a powerful experience:

*"For me every lesson is a mini action research project. This project has reminded me of the value of risk taking. It is energising, informative, creative and enlightening."* [GiP10]

In addition some of teachers involved had taken over classes that they identified as unruly or disruptive; they found that the interventions that involved students to a greater extent also greatly assisted with classroom behaviour.

Many teachers recognised their action research projects as the start of a process of bringing about change, and have already identified next steps and new questions for action research. Participating teachers were also realistic that not all learning and teaching styles suit all students and recommended building up a portfolio of varied activities and approaches:

*“We are seeing some attitude shifts in young people and improved understanding of physics. Some students did enjoy the changes, some did not. There is certainly no such thing as one size fits all. Encouragingly our data has shown a strong increase in GCSE module test scores for girls as well as for the boys.” [GiP10]*

In summary teachers identified key supportive actions when making changes:

- Small changes are most manageable and sustainable;
- Taking risks in teaching can open up new ideas and teacher skills;
- Sharing information is vital for reflection - with colleagues for support and involvement, and with students to gain their views and experiences of changes.

### **Improved planning for learning and teaching resulting from listening to students' views**

Listening to students' views on their experiences of physics had a profound impact on many participating teachers, and students' suggestions also improved the planning of some of the action research projects. Several teachers were shocked at their students' attitudes to science and physics in particular, ranging from 'extremely boring' to 'too hard' to 'disinterested'. Making physics more attractive to students was a key concern during project planning for many of the action research interventions:

*“Our main issue is not just with take up with physics but also with science and a negative attitude to science in general. The pre-questionnaire we did on students' attitudes was a big wake up call to the Department. We were shocked just how much students hated science, and this generated a lot of discussion about how we would tackle this.” [GiP57]*

In addition the students themselves were keen to have their voices heard and felt some teachers misunderstood their motivations for asking questions. Some students reported that they liked to discuss the science, and that when they don't understand they preferred to ask friends first, and then ask the teachers.

*“[Teachers are] asking questions just to see if [we are] listening, not if [we] understand. Teachers have one explanation [in the case of students talking in class]... that students have not been listening... Also depends on attitude of pupils...but you have got to meet the teachers half way.” [GiP1]*

Girls appreciated being involved and contributing ideas to the project.

*“The way I see the project [is] not to make physics girly but to make girls like it.” [GiP2]*

*“[We] know how much teachers do, planning and resources... [we can] identify and understand types of teaching. Make it relevant, make it fun.” [GiP2]*

Continuing to ask students for their feedback on activities is a central part of action research which teachers appear to have embedded in their practice. In summary, listening to students' views impacted on teachers and students in a number of ways including:

- Teachers gained access to and a better understanding of students' views about their subject and how they felt about learning;
- Students identified what aspects of teaching support and/or act as barriers to their learning;
- Hearing students' views about physics learning helped to re-frame and shape the intervention by drawing on what students had suggested;
- Most of the teachers intend to use consultative mechanisms again in future for planning and trying out new approaches as well as evaluating their effects.

### **Increased motivation and engagement of girls (and boys) promoted by effective learning and teaching strategies**

Teachers and students reported increased motivation and engagement in physics during the action research projects. As mentioned above, involving students as part of an action research process has positive effects on students and teachers alike. In addition, specific effective teaching approaches are influential on pupil motivation to learn and engagement with learning.

Personalised learning was promoted through enabling students to have choices; in the way they could respond to tasks, in the way they could contextualise problems and approaches to investigations and reporting. A personalised approach enabled students to think about the science in their own ways and to bring different skills to develop and demonstrate their understanding of physics concepts. Approaches teachers used included student developed materials (analogies, starter activities, experiments) drawing on other disciplines (drama, art), independent learning (whiteboard responses, choice of context) and co-operative learning (collaborative research, project teams with rotating roles).

*“A second focus of our intervention and for my own teaching in particular was to use the methods to allow a personalised choice of methods for the students to describe their understandings and learning. Activities here included Role Plays where students are given a choice of phenomenon to describe the properties of, the effects of, the uses of. The role played discussions arising were ‘science talk’ and meaningful talk about science. Another activity is ‘Hot Seating with Experts’ where students research a topic over three weeks by using the internet, books, talking to the teacher until they became the experts on that topic. We then had talks from the experts where students could ask the expert teams and vice versa about the topic under discussion. We found that by drawing on the drama experience the young people already had, the students were confident in transferring these skills to understanding physics.” [GiP10]*

Student-led teaching was supported by several teachers including those schools where pupils were involved as young researchers. This included Year 9 students leading a physics class for Year 2 students, which succeeded in consolidating their learning and greatly enhancing their confidence. Another group of Year 10 students worked with the teacher to jointly deliver a series of classes to a Year 9 class with a strong influence on both the student facilitators and students in the class.

*“[We] help them to enjoy the class by designing the lessons. We knew what it’s like to be in a class and not understand, we understand where students struggle.” [GiP2]*

*“[We have learned] how to learn, how to share with others.” [GiP2]*

In summary, teachers and students identified four approaches that influence students’ motivation and engagement with learning:

- Personalised learning based on knowledge of the range of students’ learning styles and additional skills;
- Independent learning to empower student choice;
- Co-operative learning to enable students to support and learn from each other as well as see the teachers involved in a learning process with them;
- Student peer-led learning based on students’ communication and facilitation skills.

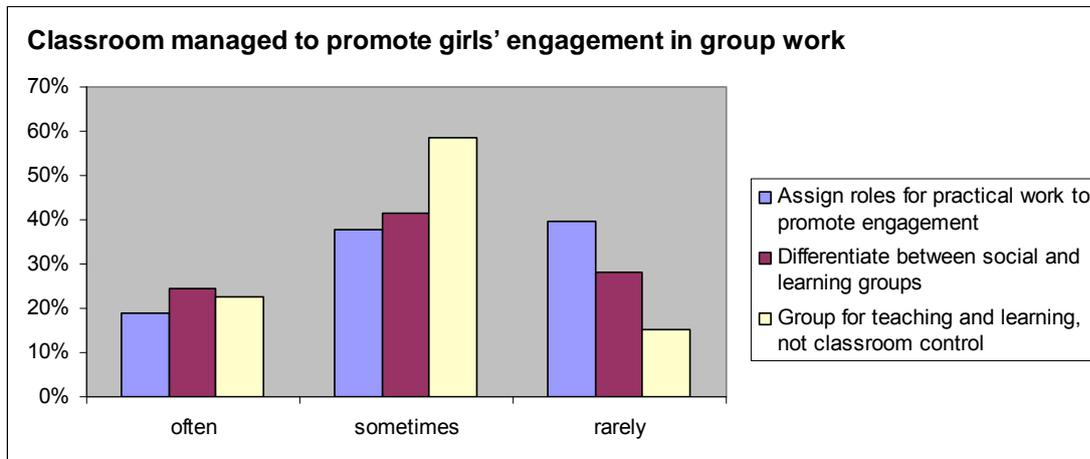
## **5.2 Classroom Management**

### ***How can the classroom be managed to promote girls’ engagement in physics lessons?***

The single-sex / mixed schooling debate is one of the most contentious in the gender and education research community. The notion of recuperative masculinity (Francis, 2000) is characterised by boys ‘falling behind’ in education and cites feminism as one of the key reasons behind this trend. While uptake in physics would likely increase if girls were to be taught in single sex groups, this approach is currently unpopular with gendered education researchers (Martino and Meyenn, 2001). The evidence suggests that while both boys and girls perform better in a single-sex environment, girls’ performance is increased by a greater proportion than their male counterparts. Some of the gendered associations with physics are less apparent in a girls-only classroom, where girls’ constructions of their own femininity are less strongly influenced by males. Working hard at a perceived ‘masculine’ subject can compromise this femininity in a mixed environment, where it is seen as less socially acceptable (Brickhouse and Potter, 2001). The Girls into Physics ‘Red Books’ do not promote a single sex approach to teaching physics. Instead, the guide for action recommends alternative ways in which classrooms can be managed to promote engagement of both girls and boys. Good practice in this area has been highlighted by Hollins et al. (2006) as:

- Assigning roles for practical work to promote engagement;
- Differentiating between social and learning groups;
- Grouping students for teaching and learning, not classroom control.

**Figure 6 - Teacher self-evaluation responses to Classroom Management at start of project**



Teachers were least polarised in their responses to this cluster. A strong majority (59%) indicated that they 'sometimes' grouped students 'for teaching and learning, not classroom control', with (roughly) approximately equal numbers indicating either side (23% 'often' and 15% 'rarely'). The spread regarding teachers 'differentiating between social and learning groups' was more even, with 42% indicating they incorporated this practice 'sometimes', 25% 'often' and 28% 'rarely'. The least common practice was 'assigning roles for practical work to promote engagement', with 38% indicating 'sometimes' and 40% 'rarely'.

### 5.2.1 The action research projects

Seven projects had Classroom Management as the primary focus. A further 8 projects had a secondary focus on this area. The projects relevant to this cluster are given in the box below.

**Classroom Management Action Research Projects**

- **Assigning roles for practical work to promote engagement [1 project]**  
 One teacher tried assigning roles to girls during practical and group work to encourage more active participation.
- **Differentiating between social and learning groups [1 project]**  
 One teacher implemented a range of different seating plans including gendered groups, friendship groups and alphabetical groups.
- **Grouping students for teaching and learning, not classroom control [1 project]**  
 One teacher split the class into specific groups to investigate different factors related to the same topic.
- **Single sex groups [7 projects]**  
 Interestingly, many teachers chose an intervention that involved students working in single sex groups, even though this was not recommended in the Teachers Guide to Action.
- **Other projects linking to this cluster [8 projects]**  
 Eight projects had a secondary focus on Classroom Management. Most of these [6 projects] had a primary focus on Learning and Teaching, where learning and teaching approaches were combined with various classroom management strategies, including assigning roles or single sex groups.

## 5.2.2 Teachers' experiences

### Assigning roles for group work

One teacher [GiP61] actively decided upon and assigned roles to girls for group work. The results were very positive - even surprising - to the teachers involved, and have resulted in a significant change of practice:

*"In the recent outstanding Ofsted inspection, one of the points for action was that learners are sometimes too passive. Informal observations within the classroom suggested that some girls relished group work and contributed enthusiastically, sometimes dominating a group and leaving little space for others to contribute in a meaningful way. Other girls were content to sit back and take little part. It was hoped that assigning roles within groups would redress this balance and allow all girls to participate in and learn from group work."* [GiP61]

Interestingly, staff and students reported different perspectives after the intervention:

*"Girls who normally did little in group work were observed participating much more fully, but they did not report this change in the survey."* [GiP61]

*"...although girls may report that they prefer to choose their own role, they respond positively when roles are set. In some cases girls responded very enthusiastically to being given an important role. In discussions the girls reported back to the group more confidently than when they had been selected as spokesperson by the group."* [GiP61]

All the staff involved from [GiP61] stated that they would assign roles in future. Considering the most appropriate way to evaluate such interventions, which might contribute to a more positive working environment in lessons at the expense of students' social preferences, is also important.

Another project combined single sex groupings and practical work by exploring the impact of particular roles assigned within the groups [GiP7]. Two Year 10 classes participated over eight weeks. Groups were organised into single gender working groups and roles allocated to ensure a fair distribution of tasks.

*"When the groups were structured, groups were a little more proactive when observations were taking place and needed fewer interventions. The perceptions of students were good...76% of students in one class preferring the structured class."* [GiP7]

The structuring and assigning of roles appeared to be a more influential factor than single gender groups.

*"The single gender groups didn't go so well. Participation appeared to be more dependent on the structure of the group as the single gender groupings didn't really affect the number of interventions. It did appear to result in more intervention for all male groups, which drew attention from girl groups"* [GiP7]

### Organising groupings for teaching and learning not classroom control

One project [GiP85] focussed on giving "more opportunities for students to talk about their findings". Groups were asked to investigate one factor and to present results to the class. Students were encouraged to discuss and use whiteboards for group responses and to evaluate the 'most memorable activity' prepared by their classmates. This produced an interesting response: the boys preferred a Mexican wave activity whereas girls preferred role play taking the role of scientists discovering radioactivity. The teacher will continue to develop group work and has formed links with the English Department and their coaching programme with a view to creating a joint activity linking English and Science.

*“The results showed a clear increase in enjoyment in their physics lessons, across both sexes. Student voice is extremely useful tool for developing your teaching...the majority of students respond well to working within groups and they DO work!” [GiP85]*

Some schools also included elements of Classroom Management in their research, even if it wasn't the primary focus:

*“The Girls Day Out allowed pupils who are normally very reserved in class to develop more confidence and to really enjoy the practical session. In the past I have tended to mix the gender in groups for practical, but there is clearly an argument for girls only”. [GiP60]*

### **Single sex groupings**

A relatively large number of projects grouped students by gender in their action research interventions. The assumption that because girls' schools on average have a higher uptake of physics post-16, grouping girls together would improve this in mixed schools is a logical one. However, interventions in this area had mixed results. One teacher [GiP16] described her approach as follows:

*“At the start of my intervention project, I rearranged the seating plan so that the students were arranged in six single sex groups of five pupils. During all activities, the students completed the work within their groups on their tables. The styles of work completed included practical, discussion, worksheet based and revision activities.” [GiP16]*

She reported the advantages and disadvantages of this approach:

*“Engagement of girls in the lessons was noticeably increased and their focus during all types of tasks was considered to be higher. This was, however, at the expense of the boys who were less likely to be on task and focussed, particularly during written assignments. The girls in the group were always noticeably harder working and during an interview with one girl she said that the “boys needed the girls on their tables to help them work”. The questionnaires clearly showed however, that the students preferred sitting in mixed groups and ideally choosing their own seats.” [GiP16]*

Students were found to be quite articulate about the advantages and disadvantages of working in single sex or mixed groups. While girls felt that some aspects of their work were improved when working in single sex groups, some felt they participated more in mixed groups and some felt that the lack of focus of boys' only groups was an issue. The teacher summarised her project by commenting:

*“I have learnt that students views are incredibly useful when carrying out research and that they are aware of the pros and cons of working in single sex groups. The girls were very aware that they were working better on their own but possibly at the expense of the boys in the class.” [GiP16]*

Another school [GiP53] embarked on a longer term project where the school is interested in looking at the effect of single sex groupings on attainment. The teacher began by splitting a Year 8 cohort in half with one half being mixed and the other half being divided into single sex groups for practical sessions. The teacher acknowledges an impact will “take some years to analyse” however “girls now seem to be enjoying the practical aspects of science more.” [GiP53]

It is undoubtedly the case that girls can work better in single sex groups. However, it appears from exploring the impacts of the work in this cluster that similar improvements in engagement can come from other strategies that do not have a detrimental effect on boys, such as assigning roles for group work.

### **5.2.3 Cluster outcomes**

#### **Impacts of effective group work**

As well as promoting engagement from all students, effective group work also had the benefit of requiring fewer interventions from teachers. In contrast, single sex groups of boys were observed to require a greater level of teacher intervention.

Furthermore, these types of intervention do not require a high level of time or resources. As one teacher commented:

*“The change has the potential to be sustained in the long term. There are no physical resource implications and two out of the three teachers involved reported that the intervention did not increase the teacher’s workload. The main obstacles are simply remembering to set roles and thinking of appropriate roles for the situation. In order to mitigate these and improve the potential for sustainability I will include explicit role setting in new schemes of work.” [WM61]*

#### **Learn from other departments**

Using strategies from other departments that may use group work in different ways, such as English or Drama, can also work well.

*“I have undergone training in the school’s VLE and have explored using forums. I have also formed links with the English Department through the coaching programme with the subject leader who is also interested in developing group work. The hope is that we can create a joint activity linking English lessons with science lessons” [GiP85]*

#### **Students’ enjoyment**

When asked about working in single sex groups, most girls appeared not to enjoy this:

*“The single sex groups improved girls understanding and confidence whereas when in mixed groups they participated and enjoyed themselves more.” [GiP48]*

Although one teacher noted that students did not report what he observed as a significant change in their behaviour:

*“I discovered how slowly girls’ perceptions can change. In the follow up questionnaire girls gave the same response as in the pre intervention questionnaire, even when significant changes had been observed.” [GiP61]*

So it is interesting to unpack the term ‘engagement’, which is more complex than just ‘participation’. Teachers and students identified a number of indicators including enjoyment, participation, confidence, concentration levels, understanding and frequency of required teacher intervention. Balancing all of these factors is not straightforward, especially in single sex groups where teachers needed to adopt different strategies to deal with the male and female groups in a single class. The complexity of this issue is probably the reason that many teachers who tried single sex groups reported that they needed a longer time and/or more evaluation to ascertain the effectiveness of their interventions:

*“I will continue to use different sexed groups in my lessons over a longer period of time to see its effectiveness” [GiP48]*

*“Initial analysis has shown little to no impact on the attainment but the timescale was very short and the intervention needs to continue for at least another 6 months before it can really be evaluated.” [GiP53]*

*“Measuring the impact of the change is a vital step that is often missed out. Completing this project has reinforced the need for the use of data to ensure that a measurable impact can be demonstrated for several reasons, including ensuring this is the best practice.” [GiP7]*

### **Balancing benefits for boys and girls**

Both teachers and students that were involved in single sex grouping projects picked up on the fact that while girls worked well together, boys-only groups would often lose concentration.

*“The girls were very aware that they were working better on their own but possibly at the expense of the boys in the class.” [GiP16]*

*“It did appear to result in more [teacher] intervention for all male groups, which drew attention from girl groups” [GiP7]*

So while some teachers felt that single sex groupings were a success because they increased girls’ engagement, it appears that this result can be achieved in a way that benefits students of both genders. As one teacher who tried single sex and mixed approaches with roles commented:

*“Groups generally worked more effectively and require fewer procedural interventions when their roles were structured than when left to organise themselves” [GiP7]*

#### **Case study: Single sex groupings [GiP48]**

*“I originally had the students sitting in a mixed seating plan decided by me at the start of the year. At the start of my intervention project, I rearranged the seating plan so that the students were arranged in six single sex groups of five pupils. During all activities, the students completed the work within their groups on their tables. The styles of work completed included practical, discussion, worksheet based and revision activities.”*

*“Engagement of girls in the lessons was noticeably increased and their focus during all types of tasks was considered to be higher. This was, however, at the expense of the boys who were less likely to be on task and focussed, particularly during written assignments. The girls in the group were always noticeably harder working and during an interview with one girl she said that the “boys needed the girls on their tables to help them work”. The questionnaires clearly showed however, that the students preferred sitting in mixed groups and ideally choosing their own seats.”*

*“I have learnt that students’ views are incredibly useful when carrying out research and that they are aware of the pros and cons of working in single sex groups. The girls were very aware that they were working better on their own but possibly at the expense of the boys in the class.”*

### 5.3 Careers Education and Guidance

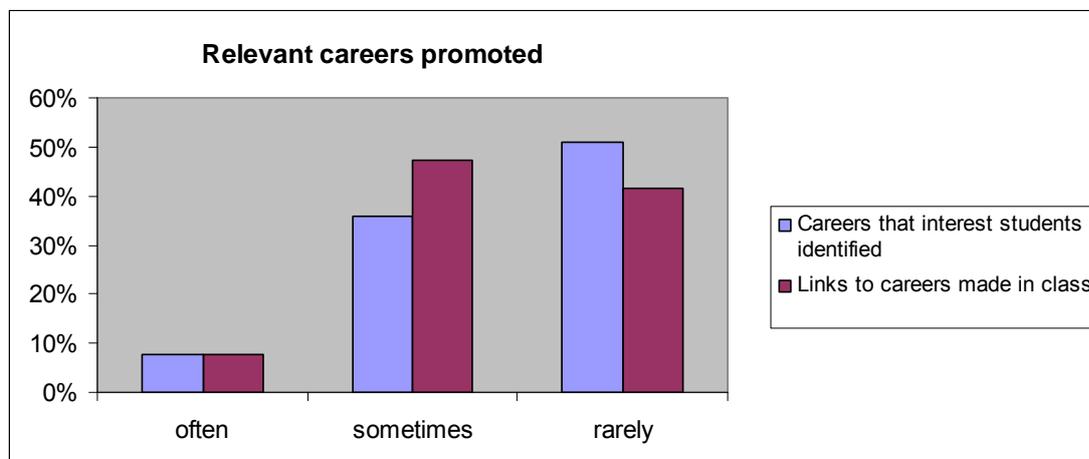
#### ***How can careers to which girls aspire be included in physics lessons? How can teachers be supported to identify and introduce such material?***

Effective information, advice and guidance (IAG) is crucial to increasing and widening participation in any subject area. Research has indicated that girls are motivated to study physics when they can see that it is part of the pathway to desirable careers such as medicine (Murphy and Whitelegg, 2006). Hence the nature of the careers presented to girls (i.e. whether they are careers that fit in with the girls' feminine and other identities) is likely to be a key factor in the success of this approach. This cluster explored which physics-related careers girls find engaging, and methods used to attract girls to potential careers usually perceived as male dominated. Similar issues related to feminine identity as those explored in the classroom management cluster were relevant here.

Research conducted as part of the Girls into Physics project to date has identified key success factors in relation to the careers education and guidance cluster. The key is that the value of careers is highlighted and actions include:

- Careers that interest students are identified;
- Reference to careers is made in class.

**Figure 7 - Teacher self-evaluation responses to Careers Education and Guidance practice at start of project**



The initial self-evaluation analysis conducted at the start of the programme showed that this cluster is the one that teachers believed is the least well developed within their schools at present. Just over half of the teachers (51%) admitted that 'links to careers were made in class' only 'rarely', whilst 42% indicated that 'careers that interest students are identified' only 'rarely'. Only 8% of teachers claimed to 'often' incorporate either of these practices.

#### **5.3.1 The action research projects**

Careers education and guidance was raised as a core issue at the final reporting workshops, not only amongst teachers who chose to focus on that aspect during their project but also amongst many of the other teachers during the workshop discussions.

### Careers Education and Guidance action research projects

- **Careers that interest students are identified [2 projects]**

Working closely with the work experience coordinator, one teacher encouraged female students towards trying out engineering and scientific work placements. Other teachers found a lack of knowledge among students about how useful science is and what career possibilities beyond “astronomer, astronaut, science teacher, lab assistant”.

- **Reference to careers is made in class [7 projects]**

Interventions included setting the students a task to create displays showing details about a range of possible careers that Physics qualifications may lead to; starting each new physics topic with a presentation about the careers it might lead to; and specific lessons entirely about physics related careers.

- **(General) Value of physics to careers is highlighted [6 projects]**

Some teachers took a more general approach, broadly highlighting the value of physics to careers. This included activities such as off-site visits specifically focused on careers, as well as careers input in Sixth Form Information Evenings, Taster Mornings and in lessons generally.

- **Other projects linking to this cluster**

Four projects had a secondary focus on *careers education and guidance*, building upon primary investigations in *progression*, *ethos* and *learning and teaching* (x2). In two cases this involved poster displays created by students about physics more generally, which incorporated some elements of careers information. In another example, careers were included as one element of wider progression discussions. One teacher observed significant crossover with the ‘Learning and Teaching’ cluster aspects, noting that it was the “*things I did*” and relevance to practical examples which had more impact, for example wind-up torches and problems of dangerous roads (relating to circular motion).

### 5.3.2 Teachers’ experiences

#### Careers that interest students are identified

In all cases, teachers identified a lack of knowledge among students about the different careers (especially non-science careers such as law) that physics could relate to, for example not recognising what career possibilities exist beyond “*astronomer, astronaut, science teacher, lab assistant.*” [GiP76]. This was outlined in the Red Books, but there was a need for most teachers to contextualise some of the literature by talking to students in their own schools and classrooms.

Some of the results regarding student impressions were surprising to the teachers involved and have enabled them to refocus their efforts appropriately:

*“I have learnt how badly informed students are in terms of which subjects are linked to which careers. (I am convinced that this applies to all subject areas) I have also been made more aware of which physics topics interest students most and need to focus my teaching on this”* [GiP65]

## Reference to careers is made in class

To counter the poor careers provision the participating teachers devised a wide range of interventions, including:

- Students were tasked with producing a poster about a career that a physics qualification could lead to;
- Careers input in Sixth Form Information Evening, Taster Morning and in lessons;
- Information about specific relevant applications included within each teaching session;
- Specific physics lessons devoted to careers work (at Year 9 level);
- School trips and off-site visits (e.g. for Gifted and Talented students) to see physics-related careers in action;
- Improved links with Universities and local industrial organisations, in particular involving interaction with female academics, postgraduates and staff;
- “Girls Day Out” at the local Science Learning Centre;
- A file of information on science careers made available;
- Noticeboards dedicated to careers set up in teaching labs;
- Careers-related lesson starters (e.g. videos).

### **Case study: Careers and relevance [GiP43]**

*“I got fed up with the dreaded questions “Miss why are we doing this?” “Where are we ever going to use this when we leave school?””*

*“Not being a Physics specialist I aimed to find out some decent answers for these disaffected pupils who were clearly bored in Physics lessons. I made a series of short film clips about the possible careers that the topics we cover in science could be linked to. The films included clips of people speaking about their job and videos of fun and abstract careers that the pupils would never have linked Physics to. Using these films as a starter made a massive difference to my lessons. Pupils were more engaged and stopped asking those questions. Instead they wanted to know about Physics careers and one pupil even made me a short power point on all the possible careers they are interested in looking at further. It was an amazing experience in which I learnt a lot from the pupils as they had an input into the lessons.”*

*“The outcome is informing the pupils of the opportunities available to them career wise will get them more engaged in the lesson being taught. Using media as a hook works really well in getting a great start to the lesson.”*

### 5.3.3 Cluster outcomes

Measuring impact was difficult for this cluster as indicators such as participation in lessons were not really appropriate. Questionnaire and interview data revealed that students appeared to find physics more relevant as a result of interventions in this area. However many teachers said they would be looking at how many students pursue physics post-16 to truly judge the impact of their work. In one case uptake at 16 has already increased.

Teachers were also keen to identify solutions that were realistic yet maintained high impact over a longer time scale:

*“A concerted program of physics related careers activities needs to be undertaken for consecutive year groups if impact is to be long term. This has time and resource implications.. I would like to provide a similar opportunity for a larger group and run the activity in a more careers focussed manner.” [GiP98]*

Most teachers are planning to continue the work they began as part of this project:

*“The work on careers is likely to remain as a post SATs / pre GCSE event for the next two years and may remain beyond this depending on changes to KS3 testing and reporting. Visits to the local 6th form will remain in place for the next four years and is now written into the Specialist Status Plan after redesignation.” [GiP29]*

#### Student career aspirations

Overwhelmingly, very few students had a clear idea of their career aspirations, which was a surprise to many teachers. One telling example was a top set (all girl) class at the beginning of Year 11 in which fewer than half were thinking of going to university, let alone to study physics [GiP88].

*“A level choices were based upon enjoyment of subject, good grades and future career; career choice became more dominant in Year 11, top for girls. However 25% pupils made choices with no firm careers intention, for girls this was 33%” [GiP71]*

*“Discussions with pupils have led me to conclude that girls are often reluctant to attempt physics A level because they believe it will be too difficult for them to achieve a high grade. They definitely believe that biology A level is an easier option, and will tend to go for that if they only want to take one science subject. These perceptions are not usually backed up by results. The girls who do take physics either love it as a subject, or need it for their chosen career - boys at our school seem to put less thought into their A level choices. Few pupils are aware of the wide range of careers that physics can support, and few appreciate the value of general problem solving / analytical skills.” [GiP60]*

#### In-class reference to careers

The results from the careers-related interventions by the physics teaching staff were very positive, for example:

*“The Sixth Form A level physicists visited Salford Uni physics department and talked to academics about their research projects; this convinced several students to apply for physics degrees.” [GiP60]*

*“Students expressed surprise at the opportunities that might present themselves to a person with a Physics qualification.” [GiP100]*

*“Students have become more thoughtful about plans for future + are more informed re. careers in science. More are considering careers in science” [GiP87]*

*“This has led to many requests for information (from both boys and girls), and several useful discussions about A level physics with my Year 10 / 11 classes.” [GiP60]*

*“The main findings are that girls need more guidance towards their study of science at GCSE which includes the best subjects for their career path not just how many lessons of science they want to study each week and if it is mainly exam or coursework based. Students especially girls need career guidance on the range of careers that need physics or where physics is an advantage. There is still a stigma associated with studying physics and there needs to be a reason to study the subject. This could be to promote how much physics is around us although there needs to be a national strategy for a successful outcome.” [GiP99]*

*“Students involved stated in questionnaire that the experience was positive in highlighting careers that they would otherwise be unaware of. Intervention has highlighted that there is lots of scope for physics related careers work although trips and visits of this nature are not really practical on a larger scale.” [GiP98]*

*“Exposure of both girls and boys to engaging physics related careers information (seeing real science, not just in-school materials) is positive in encouraging interest and potentially uptake of Physics at post 16 and beyond.” [GiP98]*

### **Improve awareness of existing physics careers support materials**

During the workshops, many teachers expressed a lack of awareness themselves regarding what provision exists for physics-related career information. Whilst some teachers (usually physics specialists) were able to offer a range of advice, it is clear that this information is not reaching all teachers.

### **Improving general careers provision within schools**

Existing careers provision was generally judged to be poor at most schools.

*“Careers advice has tended to focus on at risk groups... with no active intervention on careers choice for the majority of pupils.” [GiP71]*

However, actively linking physics careers into existing provision worked successfully and is worth pursuing. Working closely with the work experience coordinator one teacher [GiP52] wanted to place more emphasis on the roles of scientists and how the concepts that they are being taught match the job opportunities. The girls were guided towards trying out engineering and scientific work placements and a major change has been observed in the students' understanding of why science is important and how it impacts on their lives. This approach to linking careers to subjects at school more closely is now part of the school development plan.

*“[After the work experience] girls changed their perceptions of physics and engineering and also revised their plans for career options. Attitudes had changed to what they saw as a physics jobs and girls wanted to look at those careers instead of traditional ones. Boys and girls didn't realise how much you need science in jobs. Now the girls try harder to be better at physics than the boys!” [GiP52]*

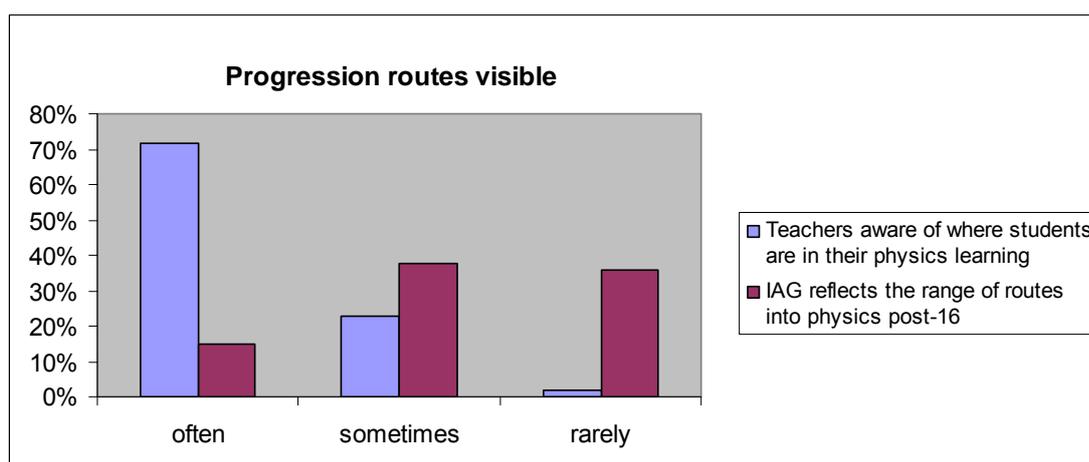
## 5.4 Progression

### *How have schools implemented successful strategies to support girls in choosing physics post-16? What pathways are provided and what dialogues occur?*

The 2005 White Paper 14-19 Education and Skills (DfES, 2005) identified the need to introduce greater choice of what and where to study for the age group. As a result, 14-19 diplomas are being introduced at three levels, with level 3 diplomas being designed to prepare students for university and other further study. The breadth of options can be confusing for students so the aim was to explore how schools can offer effective support. The key here is to ensure progression routes are visible to students and teachers, and teachers are positive about students' potential. The collaboration between teachers and careers advisors was also explored. Good practice in this area of has been highlighted by Hollins et al. (2006) as:

- Teachers are aware of student ability and confidence in levels of physics;
- Information, advice and guidance (IAG) reflects the range of routes into physics post-16.

**Figure 8 - Teacher self-evaluation responses to Progression practice at start of project**



The self-evaluation analysis for progression routes showed that teachers were very confident in knowing 'where their students are in relation to physics learning' however teachers are less convinced that 'IAG reflects the range of routes into physics post-16 within their schools'.

Interestingly, the e-survey also highlighted some supportive practice in this area, particularly through aspiration and enrichment activities. Schools indicated strong links with Aimhigher, with some generic activity around progression to HE science and providing IAG to make progression routes explicit. Targeted taster activities such as Physics HE Taster Days and work placements at University centres for physics research were also popular. Certain Aimhigher activities focused specifically on science (and physics in particular) as relevant to all and especially highlight the value of physics to careers.

### 5.4.1 The action research projects

Progression action research projects
<ul style="list-style-type: none"><li>• <b>Teachers are aware of student ability and confidence in levels of physics [1 project]</b></li></ul> <p>Sessions were developed that firstly focussed on opportunities afforded by physics qualifications, and secondly that raised the profile of physics through a series of design and build mini projects based on a humanitarian disaster relief exercise.</p>
<ul style="list-style-type: none"><li>• <b>IAG reflects the range of routes into physics post-16 [0 projects]</b></li></ul> <p>Initially, this aspect was selected by eight teachers. However some of them did not complete the project, whilst others moved towards a more general <i>progression</i> investigation.</p>
<ul style="list-style-type: none"><li>• <b>(General) Progression routes visible [5 projects]</b></li></ul> <p>Five teachers took a more general approach, broadly investigating how to improve the visibility of progression routes. This included activities such as arranging external speakers; visits to workplaces relevant to the GCSE syllabus; raising awareness with Maths to emphasise links when discussing A level; A level info and taster lesson delivered to Yr11; and an all-female panel session for visiting Yr 10 students as part of a Science Day at a college.</p>
<ul style="list-style-type: none"><li>• <b>Other projects linking to this cluster</b></li></ul> <p>No projects incorporated <i>progression</i> as a secondary element within their research.</p>

### 5.4.2 Teachers' experiences

Within one school [GiP56], initial research with a cohort of Year 10 students identified “24 girls ... who have the academic ability to do Physics at A level, but not the inclination” and the girls “generally did not see physics as a path to any career they found worthwhile.”

Building on this, sessions were developed that firstly focussed on opportunities afforded by physics qualifications, and secondly that raised the profile of physics through a series of design-and-build mini projects based on a humanitarian disaster relief exercise.

Other teachers [GiP72] tailored this by year group, finding out about students' experiences and knowledge to date and planning 'challenges', 'club activities' and 'careers activities' to match. One school worked with AS students as physics ambassadors who produced a video to show students working together using transferable physics skills in other areas.

One sixth-form college [GiP69] ran a dedicated one-hour Girls Into Physics session for visiting Yr 10 students as part of a science day at the college. This involved a panel of women comprising the careers officer, two AS students, an astronomer, an environmental scientist, and the (female) physics teacher. The session consisted of an informal discussion about studying Physics at AS level. Due to timetabling and logistical reasons the final turnout was relatively poor however the teacher involved commented “*the discussion we had was enlightening for all involved*” and plans to repeat it, with an adjusted timetable, in future years.

Two schools have started to work on development plans with feeder primary schools. [GiP55; and GiP57 reported in Learning and Teaching]. This involved developing fun and practical activities for Key Stage 2 and Key Stage 3 classes. This was successful in encouraging the primary students to enjoy science and to think positively about secondary school. Staff have begun sharing their experiences of developing activities and schemes of work together and can develop further with senior management support.

*“Feeder schools are already asking about when we are going to pay them a visit to work on magnets, light etc.”* [GiP55]

### 5.4.3 Cluster Outcomes

A variety of interventions were applied by the teachers involved, with the research focusing on which of these interventions was most successful in supporting girls choosing physics. Due to the long-term nature of such effects it is difficult to isolate absolute successes, however indications to date are positive for certain elements, particularly the introduction of role models at all stages of progression. Pupils reacted well to the involvement of a wide range of role models to represent the different progression stages. In particular, involving current AS-level students in advertising to potential students - whether via informal chats or creative media such as videos - was seen as very effective in overcoming possible negative preconceptions associated with studying physics. Exposing female students to external female role models of all ages improved both their perception of what physics careers are possible as well as reassuring them that they are capable of succeeding. This also extends to links with feeder primary schools, where early use of role models can improve students' perceptions of science even before they reach secondary school.

## 5.5 Workforce

### ***How are schools deploying and developing their workforce to help increase uptake in physics?***

Much physics education research has highlighted teachers as one of the most influential factors in the uptake of physics (Murphy and Whitelegg, 2006). Good teachers with specialist physics knowledge are an invaluable asset to encouraging greater uptake of the subject. However, due to declining numbers of physics graduates (and greater demand for these graduates from industry and the financial sector), too few such specialists exist. A recent debate in the letters pages of the Institute of Physics newsletter *Interactions* (2007) put forward the view (which was rejected by many specialist teachers) that non-specialists could help make the subject more accessible. This cluster includes the views of both specialists and non-specialists.

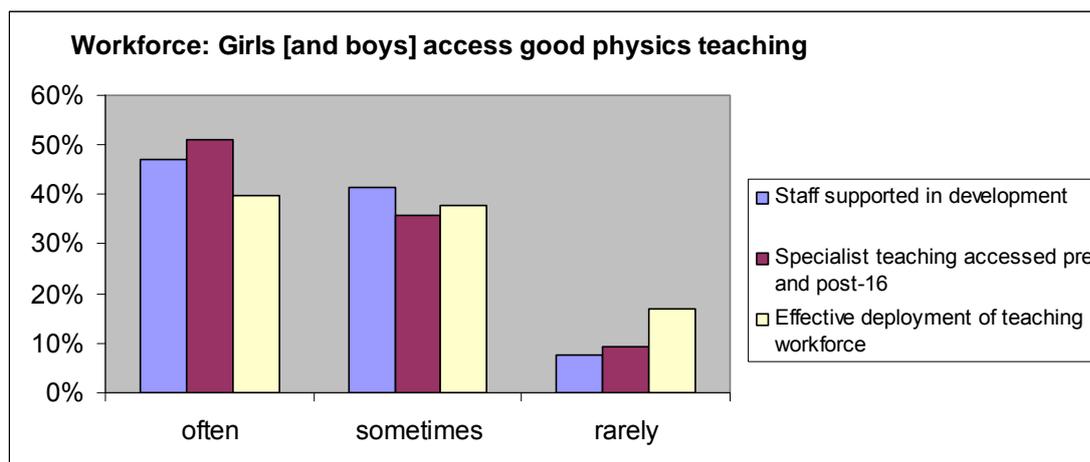
As was commonly reported by teachers throughout the programme, many non-specialists felt underconfident about teaching physics, and there was concern that this lack of confidence was transmitted to the students. One school [GiP97] took this investigation one step further and compared the difference in attitudes amongst *teachers* of different genders. The results in fact tallied well with those published more broadly for pupils:

- Male staff felt that physics was far more important than female staff;
- Female staff found physics more difficult at school;
- Male staff find physics more exciting and interesting than female staff;
- Both male and female staff feel physics is a hard subject to study;
- Female staff generally had a negative experience of physics at school.

The Girls into Physics project to date has identified key success factors in relation to the workforce cluster. They are that:

- Staff are supported in development;
- Specialist teaching is accessed pre and post 16 to give continuity;
- There is effective deployment of the teaching workforce available in a particular school.

**Figure 9 - Teacher self-evaluation responses to Workforce at start of project**



Teachers reflected general confidence towards students' access to good physics teaching at their schools. A majority (51%) indicated that students 'often' had access to 'specialist teaching pre- and post-16'. 89% acknowledged that staff were 'supported in development' at least 'sometimes', whilst roughly equal numbers (40% and 38%) indicated that the teaching workforce was 'deployed effectively' 'often' and 'sometimes' respectively.

### 5.5.1 The action research projects

<b>School Ethos action research projects</b>
<ul style="list-style-type: none"> <li>• <b>Specialist teaching accessed pre- and post-16 [1 project]</b></li> </ul> <p>One school provided a class with specialist teaching and explored the impact of this.</p>
<ul style="list-style-type: none"> <li>• <b>General approach [1 project]</b></li> </ul> <p>One school used a team teaching approach to physics.</p>
<ul style="list-style-type: none"> <li>• <b>Other projects linking to this cluster [3 projects]</b></li> </ul> <p>Three projects had a secondary focus on Workforce. These came from the Learning and Teaching and Careers clusters. One promoted INSET within school and another focused on Schemes of Work.</p>

### 5.5.2 Teachers' experiences

Just two projects had a primary focus on this cluster, although several other projects had implications in this area. The two projects looked at different ways of effectively deploying specialist physics teachers in the schools.

One approach to overcoming the lack of confidence expressed by non-specialists was 'team teaching' with a specialist physics teacher. In one particular study with Year 9 students:

*"The teacher concerned had not taught physics to a top set in Year 9 and wanted support. I was the only specialist physics teacher in the school and wanted to see how effective team teaching would be. Was it worth doing with other staff?" [GiP92]*

When the intervention was informally discussed with pupils they made it clear that the non-specialist's lack of confidence was obvious to them, however they had in fact found her explanations entirely adequate. In addition:

*"On talking to pupils, it was clear they had enjoyed the input of another teacher... The teacher concerned was more confident and has subsequently used some of the strategies. We were both concerned that she had conveyed to pupils the physics was too difficult for her and consequently the pupils". [GiP92]*

This last point was the most significant issue for most teachers involved; just as pupils often feel less confident than their results demonstrate, many non-specialist teachers also feel under pressure and subsequently convey their lack of confidence to the students.

In one case of the introduction of a specialist physics teacher the intervention was not at all successful:

*"Students were "unimpressed" by the change in teacher for each topic and have voiced loud complaints that they prefer the same teacher all the way through the course. Some students have staged their own intervention in relation to the gaining back their own original science teacher!" [GiP64]*

Arguably this was in part due to the timing of the intervention: by this point the students had been taught by the same (non-specialist) for almost two years, and saw the intervention as being 'abandoned' by their normal teacher:

*"Any changes that are made in the future regarding specialist topic teaching will need to be done from a much earlier stage i.e. the end of year 9 or start of year 10 and embedded as "the normal practice" for it to be successful and sustainable over a longer period of time." [GiP64]*

### 5.5.3 Cluster outcomes

Building confidence in teachers as well as students was seen as a positive impact from the team teaching approach trialled in one school. In that example, gathering feedback from students, who were satisfied with the non-specialist's explanations, was also useful.

Much emphasis is given to the importance of specialist physics teaching and in one case this was at the expense of a good relationship that a non-specialist had built up with a class. While the depth of knowledge and confidence of a specialist are important factors in good physics teaching, the successful intervention introduced them in a way that didn't compromise other aspects of good teaching. Appropriate timing for an intervention and consulting students during the process give interventions in this area the greatest chance of success.

Many teachers were able to share the findings of their action research projects with colleagues in their departments and schools, which allowed good practices to be adopted more widely. Including students' voices in these presentations was a powerful way to affect change in practices.

In addition, many teachers cited the opportunity to work with other teachers at the two workshops held at the Science Learning Centres as a useful opportunity to reflect on their own practice and listen to the experiences of others:

*"It was very interesting to hear what other schools had done - well worth it just for that!"* [GiP92]

*"Practical tips from other teachers of things to try in lessons were particularly useful"* [GiP16]

*"The event itself was tremendously important, meeting everyone and learning from them. The time to reflect and renew teaching methods was immensely valuable and has refreshed my attitude to new techniques and new teaching technologies"* [GiP17]

*"The project is much needed. For my own practice it has been essential for my own further development!!! Completely caused me to look at my practice from a new angle"* [GiP68]

*"This has been an enjoyable experience which I believe has encouraged me to develop my own classroom practice"* [GiP20]

## **5.6 School Culture**

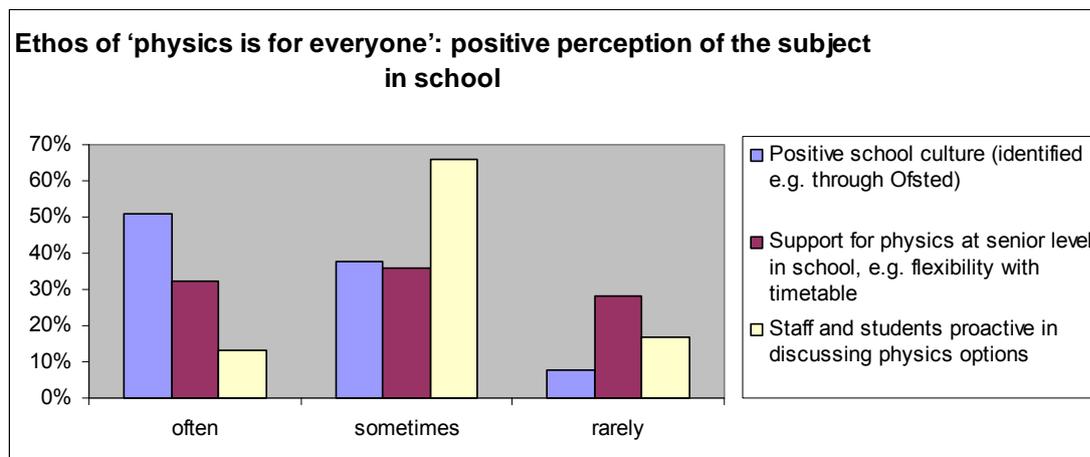
### **How are schools promoting a positive culture in relation to physics, and what are the mechanisms for effecting culture change?**

A positive and supportive school culture is beneficial to every student, every teacher and every subject. Hollins et al. (2006) described the way in which the impact of this 'can-do' culture is unlikely to be peculiar to physics, but stimulated students' self-belief in their abilities in all subjects.

Research conducted as part of the Girls into Physics project to date has identified some factors that contribute to an ethos of 'physics is for everyone' within schools:

- Positive school culture;
- Support for physics at senior level in school, e.g. flexibility with timetable;
- Staff and students proactive in discussing physics options.

**Figure 10 - Teacher self-evaluation responses to School Culture and Ethos at start of project**



Teachers indicated a varied level of incorporating the specified practices within this cluster. A 'positive school culture' was 'often' incorporated by a majority (51%) of teachers; however a strong majority (66%) indicated that 'staff and students were proactive in discussing physics options' only 'sometimes'. The 'support for physics at a senior level' produced a wide range of responses, with (roughly) approximately even numbers in each category.

### 5.6.1 The action research projects

No teachers felt able to effect a change in school culture as part of their project. Interestingly, the teachers' guide to action (Hollins et al., 2006) states that it is unlikely that school cultures can be changed quickly, so the fact that few teachers aimed to work in this area was unsurprising. However, some projects that started out on a smaller scale eventually had an impact in this cluster. In fact, successful interventions in all of the other clusters will contribute to a positive school culture, so these aspects of a range of projects are reported here.

<b>School Culture action research projects</b>
<ul style="list-style-type: none"> <li>• <b>General approach [1 project]</b></li> </ul> <p>One project worked with a group of girls to create a prominent display about physics in the school hall.</p>
<ul style="list-style-type: none"> <li>• <b>Other projects linking to this cluster [4 projects]</b></li> </ul> <p>Four projects had a secondary focus on School Culture. These came from a range of other clusters including Learning and Teaching, Progression and Careers. Several projects focused on the relevance of physics through various enrichment activities.</p>

## 5.6.2 Teachers' experiences

### Involving students

Like the teachers involved in the action research, students with an interest in physics can also be frustrated by their peers' negative opinions of the subject. One group of Year 10 student researchers commented:

*"We decided we wanted to see how having a better understanding of The Big Picture of physics would help girls. Also we wanted to see if younger girls knew what physics was all about. Since we were ending year 10, we thought we could make our classmates think about physics and careers" [GiP24]*

A teacher at another school described the process of actively involving students as researchers:

*"Using the young researchers was the most enjoyable aspect of this project. They were good role models and I would like to use them again in the future to question students before they take their options. Students interviewed were able to be far more honest in their responses with them." [GiP31]*

There were a range of benefits to involving students as researchers:

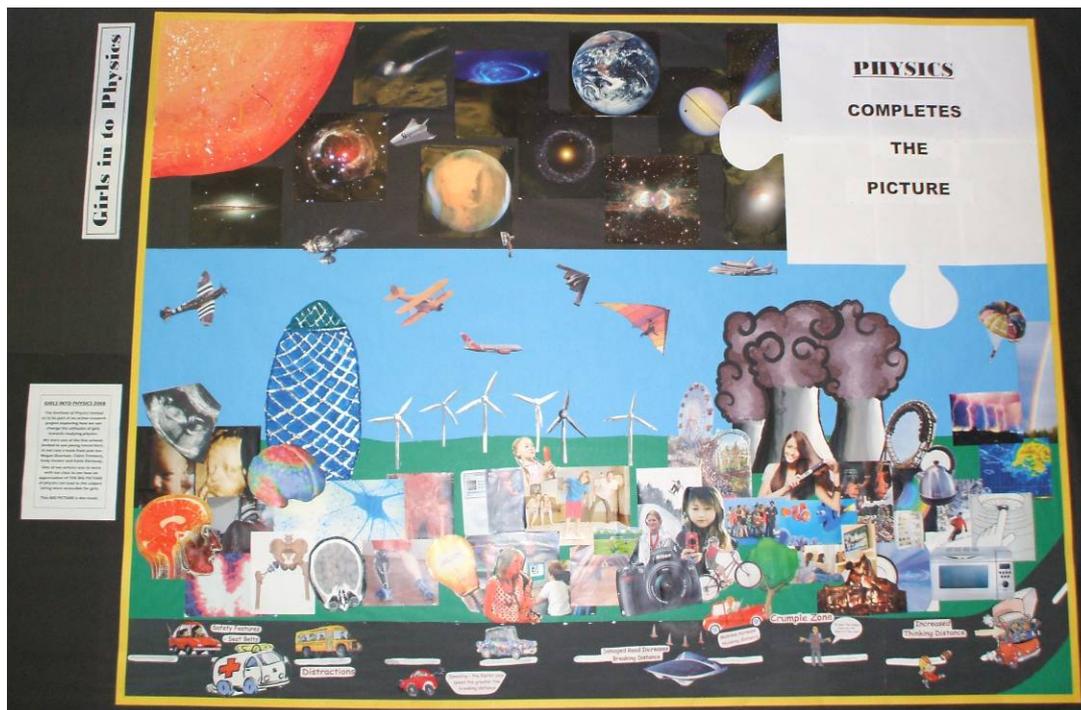
- The students' input into the interventions often meant they had a greater impact;
- The student researchers acted as positive role models for physics in the school;
- Using students to interview other students may have eliminated some bias from the research findings;
- Student researchers were inspired by the process and it had a strong positive impact on their own attitudes towards physics.

One of the teachers involved also hopes to build on this project with some further work on student voice:

*"It has inspired me to want to do a MA in education. I am hoping to do some CPD on student voice with staff at school." [GiP31]*

### Whole school interventions

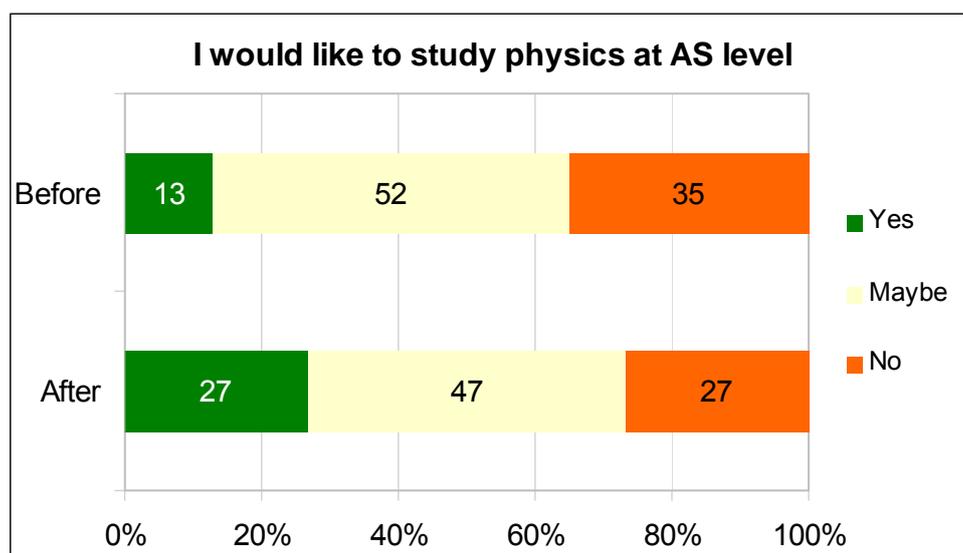
At the planning workshops, teachers found it difficult to conceive ways they could have an impact on the whole school. However, one group of student researchers [GiP24] had no such misgivings, and set about creating a large physics-related display in the school hall / dining room:

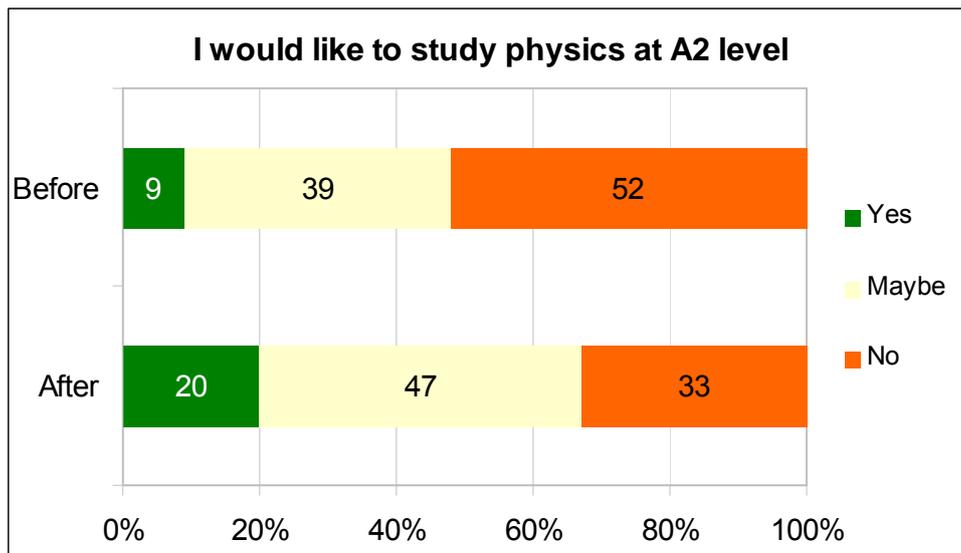


The students commented:

*“Our ideas of what we wanted to do were very different to those our teacher had. She was a bit horrified at the prospect of making a massive display that the whole school would see!”*  
[GiP24]

The Year 10 triple science class worked together to produce the display, then the student researchers interviewed students lower down the school at break times before and after it was installed. The graphs below summarise the quantitative results:





56% of Year 9 students said they knew what physics was before the display was created. Afterwards, 93% said they knew what physics was. The student researchers said:

*“Because Year 7, 8 and 9 study mixed science in individual topics, they don’t always know what topics are physics, chemistry and biology. They seem to think all topics are physics. One Year 9 wrote on her survey that she didn’t have any physics lessons so couldn’t answer any of the questions!” [GiP24]*

They felt that raising awareness of which topics were physics would help other students see its relevance.

More Year 10 students (that helped create the display) said that they find physics interesting, that they find physics relevant to their lives, that they feel motivated to do physics and that physics is important to the future of the world. Their teacher said:

*“It seemed that our action had a positive effect on the views of the Year 10 students. Creating the big picture led to a lot of discussing of the many different ways physics is relevant to our lives and our futures.” [GiP24]*

The GiP24 teacher noted that the student researchers acted as positive advocates for physics throughout the school and that this had contributed to the effect on the younger students. This was a powerful mechanism for improving the physics culture.

### **Teachers’ attitudes towards physics**

The Girls into Physics action research projects revealed several factors that are likely to erode students’ (and especially girls’) self-belief in their abilities, specifically in physics. One teacher said the most striking aspect of his action research project, which involved working closely with a focus group of Year 10 female students, was the impact that apparently throwaway comments from other teachers had on them:

*“The girls were aware of several occasions where staff at the school who were not Physics specialists had ‘put down’ Physics as being ‘too hard’. They also commented that many of the staff had admitted that they either found Physics boring or that they didn’t like teaching it. This had had a negative effect on them.” [GiP39]*

Such comments are likely to have a greater effect on students when related to a subject like physics, where girls may see the teachers' opinions as reinforcing their own negative preconceptions about the subject. This slide from the presentation he gave to colleagues in his department summarises his recommendations to other staff and includes some of the comments that the girls referred to:

**Not Physics!**

This is Physics so you'll find this hard.

I'm not sure what I'm talking about

We'll do this bit quickly because its difficult

The girls said that Physics had a negative image because staff had said that it was the 'boring' or 'difficult' Science.

**Try not to put Physics down! Even if its not your favourite Science**

### 5.6.3 Cluster outcomes

Many teachers wished to highlight the relevance of physics, but this was difficult when students did not have a clear idea of the differences between the different subjects. Creating space for these discussions in classrooms facilitated the way in which students make linkages and placed physics in a wider context. The impact of making physics more relevant in this way is discussed in greater detail in the other clusters, but essentially it improves what Murphy and Whitelegg (2006) describe as students' 'physics self-concept'. This impact is not necessarily limited to girls.

Teachers cited using student role models as a success factor. The student researchers gained a new status through their role in the project and acted as valuable role models for their peers. Teachers were impressed at students' commitment to promoting physics and all have said they wish to continue working with the student researcher groups.

*"I think that using the students as young researchers in itself motivated them - they liked having their opinion listened to!" [GiP31]*

Teachers worked especially closely with students in the projects that had an impact in this cluster.

*"The year 10 girls' focus group was an eye opener to how girls view physics" [GiP39]*

Several teachers have now embedded this type of work into their teaching practices and one has been inspired to pursue an MA in Education as a result. [GiP31]

A lasting change in one participating department [GiP39] came about because girls felt teachers' negative views on physics reinforced their own beliefs that the subject was difficult and boring. Simply highlighting this to other staff has led to a greater awareness in the department to ensure teachers aren't acting as a negative influence.

Another teacher whose project is reported in more detail in the workforce cluster picked up on this point:

*"[I learned] not to allow teachers to put themselves down in terms of their physics teaching, especially in front of the pupils"* [GiP92]

## 6. Process evaluation

The participating teachers were invited to comment on their experience of how the Girls into Physics Phase 2 project was run, including identifying any particularly useful aspects or specific ways to improve a similar project in the future.

Teachers were extremely positive about their experience of the project. They particularly valued the opportunity to **share and discuss ideas** with other teachers: *“It was very interesting to hear what other schools had done - well worth it just for that!”* [GiP92]. The value of the workshop discussion sessions was also observed directly by the research team, who noted that teachers became very animated and passionate about being able to share common concerns and work together to try to tackle the problem. Many teachers (especially those early in their careers) expressed relief that the issues they were experiencing were not unique to their own teaching or school, and appeared to gain both confidence and enthusiasm from the discussions during the workshop sessions.

Many teachers commented that participating in the course enabled significant **personal development**:

*“The whole course has been very useful, not just for developing my own research, but for sharing good practice with other teachers and having time to reflect on my teaching.”* [GiP15]

*“The most useful aspect has been that it has given me the time to reflect on how I teach Physics and how I can improve my teaching to make it more interesting and engaging”* [GiP39]

The **action research process** was new to most of the teachers involved in the project. To assist teachers with this new methodology, the first workshop included an extensive discussion about what action research involved, and teachers were required to submit an initial research proposal outlining their plans. The External Research Team reviewed these documents and identified a number of proposals which were technically more basic research (i.e. data gathering) than ‘action’ research (monitoring an intervention). The relevant teachers were then contacted in order to assist them in clarifying their plans. However at the end of the project there were still a small number of teachers who had effectively completed a pure research project. Performing the research (e.g. by distributing the questionnaire outlined in Hollins et al. (2006)) was extremely insightful for many teachers, who expressed surprise that their findings were so in line with the national results. In many cases this was very empowering, and encouraged the teachers to further trust the other findings from the Red Books (Murphy and Whitelegg, 2006; Hollins et al., 2006). For this reason, in future it might be appropriate to deliver a two-stage process, whereby each teacher first performs the necessary research and *then* applies an intervention. Splitting the process into the two separate components may help to clarify that the intervention (action research aspect) is necessary for success.

Those teachers that did deliver an ‘action’ research project were frequently surprised at how successful the more **qualitative methodology** proved:

*“I have really enjoyed doing this action research and can’t wait to see the future results. I would not have believed that it would cause such a good effect.”* [GiP43]

*“...recognise the value of qualitative data... Developing positive attitudes and skills for life are as important as test results.”* [GiP10]

Specific **methodological aspects** on which teachers would have appreciated further advice included:

- Appropriate statistical analysis methods;
- Simplifying the questionnaire so that results could be more easily compared;
- All forms (including the reporting template etc.) provided at the start of the project so that teachers knew from the beginning what information was required.

The **project timescale** was frequently raised as a key concern. The time allowed for delivery was generally considered too short, partly due to the teachers' other commitments and partly due to the time of year it was run (March - September):

*"I feel that, although a considerable amount of time has elapsed since the planning meeting, the process of planning, carrying out and analysing the research has ended up being rather rushed. This was in the main due to the pressures of working hard with exam groups and, as a result, waiting until after the exam season to carry out the task."* [GiP100]

*"The hardest part was just finding the time to do it"*. [GiP93]

However there was no consensus amongst participating teachers as to the best time of year for this project to be delivered. Some teachers expressed a preference for the start of the academic year, so that the project could be aligned with teaching a new cohort of students, whilst others would have liked to start in June to coincide with freed up time due to the departure of examination students, with feedback around mid-November.

Fundamentally, many teachers felt that major results were only possible in the longer term, and not feasible within the scope of this project: *"Excellent idea but the timescale is far too short to see any significant results."* [GiP53].

The teachers were unanimous in their support for the **programme design**, consisting of two separate workshops with a tangible project delivery in between:

*"This is a very effective method of staff development. Having a project to concentrate on and time to reflect on learning has been a useful focus following the original stimulus to ensure that developments have been followed up. I plan to use this approach with other colleagues to help them develop their teaching and learning."* [GiP7]

Teachers particularly appreciated the facility to **choose their own direction** as appropriate to their personal teaching and school environment:

*"The project has been run effectively, without any pressure on individual schools to follow a prescribed approach. This sort of freedom has made it pleasant and worthwhile to participate."* [GiP60]

The necessity of both the **two workshop days** was frequently highlighted as a major benefit to the programme:

*"The main advantage of the GiP project was time for reflection during the day to plan the activities in advance. Time is such a premium in school that it can be difficult to find time to plan new activities and the project would not have got the kick start it did."* [GiP29]

*"[The] feed back session is essential in keeping me going - I can see an end point."* [GiP32]

Many teachers identified areas where they would have appreciated **increased personnel support**. These included:

- More involvement directly within the schools, including visits to all schools;
- Being provided with some examples of previous successful projects
- A 'buddying' option whereby two or more schools work together or even get the students from different schools comparing ideas;
- More 'local level' meetings (possibly in the evening) between teachers from a cluster of schools, to share ideas and support.

The inclusion of a small stipend to **provide cover for teachers** participating in the project was very well received. Indeed, most schools would not have been able to participate without this incentive:

*"Any course / project that does more than just discuss issues by backing up possible answers with funding will succeed."* [GiP55]

*"I don't think I would have been able to participate unless cover was paid, so that was crucial!"* [GiP60]

The dedicated online **community area** on the Science Learning Centre portal was received with mixed results. Although the portal was invaluable during the workshops as a way of locating materials and referencing work to date, difficulties were encountered, both in terms of in teachers' independent use of the portal as well as technological breakdowns. At many of the workshop sessions it was not possible to effectively access this portal, either due to technical problems or because the teachers did not have their usernames and passwords. Other issues identified included differing experience and familiarity with uploading material, a lack of specific responsibility for developing / monitoring a discussion forum, and the lack of necessity to use the portal, mainly due to the existence of other ways of communicating with the Science Learning Centres (direct email, individual regional portals etc.). Most teachers only used the portal during the workshop sessions, however those that did try to access it at other times found it beneficial:

*"It has been useful to have the portal as a central place to upload any forms."* [GiP50]

Finally, teachers were overwhelmingly positive about the **management and delivery teams** involved in the project:

*"This has been an enjoyable experience which I believe has encouraged me to develop my own classroom practice. The project has been well organised and delivered in a professional and charismatic manner. Well done to all involved."* [GiP20]

However the External Research Team feel that there was a **lack of clarity over roles** in delivering the workshops and supporting teachers with their projects. Approaches varied widely between regions. For most workshops, the researchers supported Science Learning Centre staff in delivery, but some workshops were run solely by the External Research Team member/s with minimal involvement of SLC staff on the day. In most regions the majority of the support in between workshops also came from the External Research Team. The support to teachers is crucial to build confidence with the methodologies and issues. The provision of such support should be considered carefully in future delivery of action research continuing professional development and evaluation processes.

## 7. Synthesis of impact

### 7.1 Successes and challenges

A number of successes and challenges in engaging girls with physics were identified by teachers as an outcome of the research projects. This section discusses these under several themes. The evidence presented here comes from two sources:

- Drawing together the teachers' action research reports;
- 'Top tips' that teachers wrote on post-it notes at the second stage workshops, that were designed to act as advice to other teachers that wish to further engage girls with physics.

#### 7.1.1 Making physics relevant

Teachers tried many approaches to making physics more relevant to girls, which means that a large number of successes and challenges have been identified. These findings come mainly from the careers and progression clusters.

<b>Making physics relevant</b>	
<b>Successes</b>	<b>Challenges</b>
<ul style="list-style-type: none"> <li>• Integrating physics-related careers throughout normal teaching (e.g. via direct reference in class, set assignments, posters and displays in classrooms etc.)</li> <li>• Extended projects that promote 'real life' opportunities and applications of physics</li> <li>• Sessions which linked physics to wider social relevance, including the relevant roles played by physicists</li> <li>• Use of role models at all stages of progression</li> <li>• Link work experience placements specifically to subject areas in schools</li> <li>• Prioritise engineering / scientific work placements for girls</li> <li>• Plan for progression from Primary if possible and Year 7 onwards</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of awareness of existing provision of physics-related careers information</li> <li>• Many students struggle to articulate their own career aspirations</li> <li>• Lack of in-school resources specifically allocated to science-related careers and/or general careers provision for all students</li> <li>• Little knowledge by students and staff (including non-specialist physics teachers as well as careers and work placement advisors) on the science involved in relevant careers</li> </ul>



- Link physics to everyday relevant experiences*
- Make it relevant - to do with people*
- Awareness of 'the big picture'*
- Show how physics can be used in jobs*
- Show relevance to people and careers - build links into schemes of work*
- Careers advice early - anything in KS3- speakers, visits, case studies*
- Research different jobs that physicists do now*
- Use external speakers to enthuse students*
- Build links with other STEM subjects to increase relevance of physics*
- Check & counter girls' negative perceptions about abilities*
- DO NOT tell pupils "I'm not very good at physics"*
- DO tell pupils "Everyone can do physics"*

### 7.1.2 Good teaching practice

Some of the successes and challenges in helping engage girls with physics were related to practice in science teaching generally. Interventions were most effective when they built on good practice. In a few cases the gender-specific aspect was given too much priority to the detriment of the overall classroom experience. These ideas came mostly from the teaching and learning and classroom management clusters.

Good teaching practice	
Successes	Challenges
<ul style="list-style-type: none"> <li>• Good teaching supports both girls and boys in learning</li> <li>• Students were empowered by being able to demonstrate their understanding of a concept using everyday language</li> <li>• Practical, hands-on sessions build understanding and confidence in physics</li> <li>• Structuring groups and assigning roles resulted in fewer interventions to keep students on task</li> <li>• Value the informal and have fun!</li> </ul>	<ul style="list-style-type: none"> <li>• Balancing the importance of specialist teaching with other factors that contribute to good teaching</li> <li>• Ensuring gender-specific interventions support general good teaching practice</li> </ul>

Teachers' top tips

*Teach application first then content*

*Allocate specific roles to students during group work*

*Give chances for discussion*

*Be aware of the barrier of language. Use games and communication strategies to get an input into the activities*

*Know your subject*

*Be enthusiastic*

*Use resources that are not gender biased.*

*Using IT modelling as a plenary to give girls 'a picture' of more abstract theories*

### 7.1.3 Individualised learning

Related to the good teaching practice theme was a smaller theme that looked at individualised learning in physics.

Individualised learning	
Successes	Challenges
<ul style="list-style-type: none"><li>• Element of student choice in responses to activities supports students feel in control of their learning</li><li>• Tailoring activities to suit pupils' interests and needs</li></ul>	<ul style="list-style-type: none"><li>• Be aware that all activities do not suit all pupils all of the time - change teaching styles and activities regularly</li></ul>

Teachers' top tips

*Personalised learning based on knowledge of the range of students learning styles and additional skills*

*Independent learning using approaches to enable students to have choices in responses, contexts and approaches*

### 7.1.4 Sharing practice

Sharing practice within and outside school was a theme where a number of successes and challenges were identified. Generally speaking, sharing ideas and practice was a good thing, although the project identified a need for more CPD in gender-aware teaching.

Sharing practice	
Successes	Challenges
<ul style="list-style-type: none"> <li>• Involve colleagues at an early stage for support and sharing learning</li> <li>• Working with other departments to develop joint group activities</li> <li>• Building non-specialist teachers' confidence through working with specialists</li> <li>• The opportunity to share experiences and ideas with other teachers at the workshops was valuable</li> </ul>	<ul style="list-style-type: none"> <li>• Building greater understanding of and confidence in gender aware teaching should be a stronger focus of CPD</li> </ul>

Teachers' top tips

*Work together with colleagues to develop ideas*

*Communication with students & staff*

*Look at your own practice*

*Having a research culture in the school leads to useful conversations between faculties*

*Talk to your colleagues early on about what you are trying to do*

### 7.1.5 Action research and changing practice

Teachers were encouraged to reflect on the action research approach to the project.

Action research and changing practice	
Successes	Challenges
<ul style="list-style-type: none"> <li>• Small changes in practice that don't take much time or resource can have a big impact on engagement</li> <li>• Involving students enriches the action research process</li> <li>• Highlighting student voice is a powerful way to effect changes in practice</li> </ul>	<ul style="list-style-type: none"> <li>• Interventions aimed at long-term change were not measurable in the short term project</li> <li>• 'Engagement' is complex so findings can be contradictory or difficult to interpret</li> <li>• What works well for girls can be detrimental to boys</li> <li>• Resource and logistical implications can make it difficult to integrate appropriate measures effectively</li> <li>• Timing an intervention appropriately so as not to cause disruption to a class is critical to success</li> </ul>



Teachers'  
top tips

*Ask your students what they think*

*Identify a 'small' change in practice as the focus. The key is to make that small change significant*

*Time interventions accordingly*

*Do something small to try out ideas and see if students learn from them and adapt activity based on reflections*

*Student researchers running the project make a big impact. Other students open up to them and take them seriously*

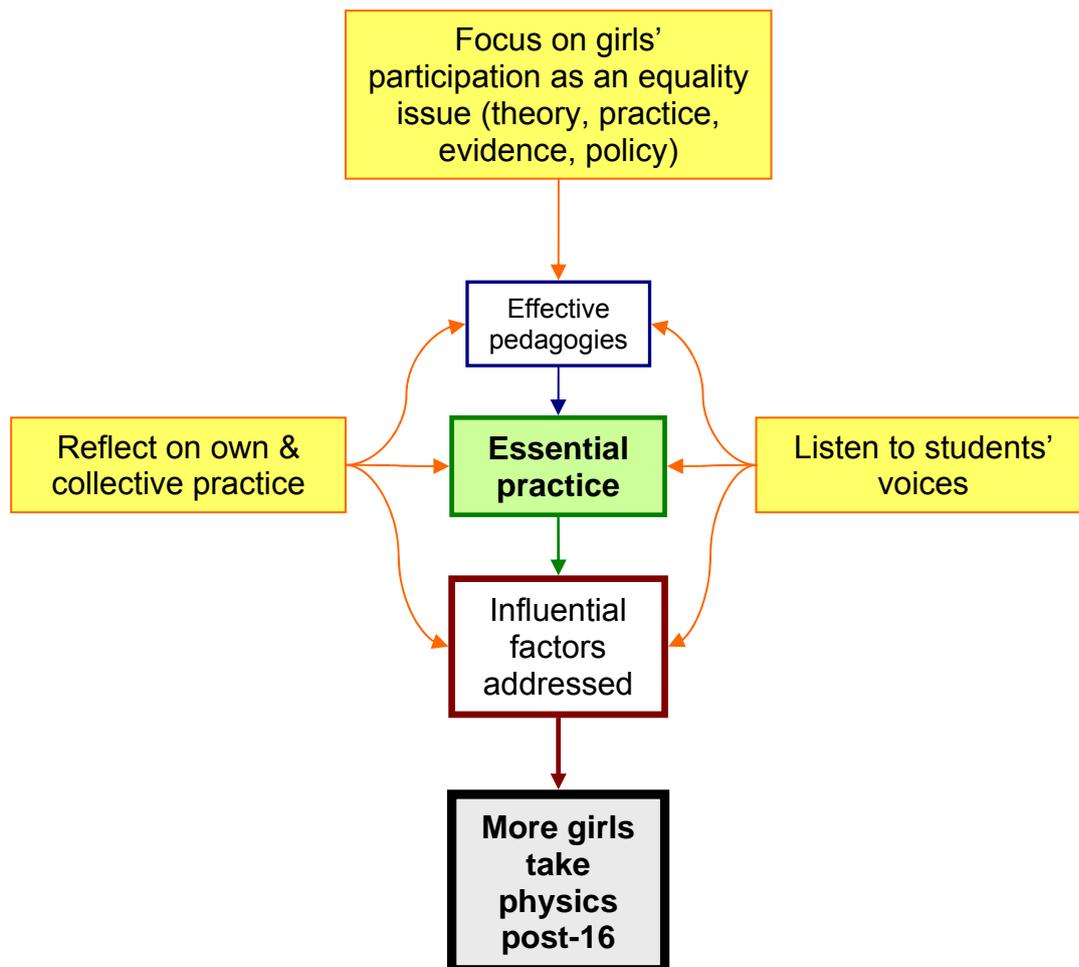
*Use former / current older students to 'spread the word'*

## **7.2 External Research Team reflection on overarching themes**

Three themes have emerged from the analysis of the Girls into Physics action research projects:

- Understanding gender equality
- Action research
- Pupil voice

These themes can be included in the Theory of Change model. They are presented here as steps for teachers towards accessing the effective pedagogies identified in the Teachers' Guide to Action. Using a simplified version of the Theory of Change, these themes (highlighted in yellow) add to the model as follows:



This section outlines each theme using case studies as illustrations.

### 7.2.1 Understanding gender equality

The action research projects provide evidence that teachers have varying levels of understanding of gender equality in relation to physics teaching. Some teachers appear confident about exploring their teaching and learning approaches and reflecting on impacts on girls' (and boys') achievement. Others appear unsure about what constitutes gender aware or gender neutral examples and resources. A few teachers resorted to single-sex groupings, either by choice or by school policy, and some have been unable to differentiate between impacts due to this and impacts due to practice changes informed by the literature review and the teachers guide to action.

Teachers appear to be exposed to a range of seemingly contradictory policy/practice messages, through the media and in school: that single-sex groups are better for girls; targeting girls' achievement has an adverse impact on boys; girls in single-sex groups eventually adopt similar behaviour patterns as boys in mixed groups; management policies of schools insist on single-sex groups; girls need female teacher role models; girls need specialist physics teachers and so on. Discussion in detail of the various policy perspectives was outside the project remit due to full agendas for the workshops. Future projects may benefit from time to discuss the wider issues of single-sex teaching year groups compared with single-sex lessons or work groups within lessons. This may support teachers to make an informed choice about different approaches.

The theoretical perspectives on gender equality seem unclear to teachers. There was not time or space within this phase for an academic consideration of the importance of gender as an equality issue and the persistent inequalities in girls' participation in physics post-16.

The Institute of Physics 'Girls into Physics' approach uses pedagogies in way that takes account of gender equality in the classroom and school. It is suggested that a consideration of gender equality in relation to theory, policy and practice will inform teachers in their current practice and have an impact on girls' participation in physics in the long term. Future continuing professional development could be strengthened by an examination of the theories underlying policy and practice and teachers could benefit from more time to consider and formulate their own perspectives and responses.

**Case study: Young researchers on gender equality** [GiP Young Researchers]

*"We need to think about changing girls' attitudes to physics including our own. If boys like it why shouldn't we? It is not about making everything pink... [it is about] trying to get equality not make it stereotypical. I like a pink fluffy room but I also play football in my area. I have two sides to me. The way I see the Girls into Physics project is not to make physics girly but to make girls like it."*

### 7.2.2 Action research

Action research has been an effective way for teachers to access the Institute of Physics 'Girls into Physics' materials. Active learning approaches in the workshops enabled teachers to identify the key themes affecting girls' participation in physics. However as mentioned above, time was too limited to explore the theoretical and policy implications of the research in depth, so it was up to individual teachers to undertake wider reading. The self-evaluation checklist was valued by teachers as a starting point for developing interventions. It allowed reflection on the issues in relation to current conditions in teachers' own schools, departments and classrooms. While looking at the whole school context may have been overwhelming for some teachers, this approach enabled them to locate their interventions in an aspect of good practice grounded in the literature.

The most successful aspect of this phase has been the space for teachers to reflect on their own practice individually and with peers. This was only possible through implementing an action research project between the planning and the reporting workshops.

The process has provided insights into how teachers use and learn from gender aware pedagogies. This type of learning has to be experiential; where teachers could try out methods for themselves. For many the starting point was very general and the project has been an opportunity to engage with the issues personally and as a school. This has led to the development of more meaningful research questions.

As scientists, teachers often felt most comfortable with measuring the impacts of their interventions quantitatively. However, many found that qualitative research methods (focus group discussions, feedback and peer evaluation) generated the most valuable data to inform and evaluate action and would use this as a starting point in the future. While some initially favoured a quantitative approach, many struggled with analysing quantitative data, in particular feedback from the questionnaires from the Teachers Guide to Action (Hollins et al., 2006: pp27-29) and in analysing school trends. Supporting teachers' skills in using, analysing and deriving meanings from both quantitative and qualitative methods would have benefitted from more hands on support and specific focus during the workshops.

This project has demonstrated that action research is a valuable way for teachers to access and use the Girls into Physics materials and to effect change in girls' participation. It is recommended that future provision continue as an extended process rather than a one-day course, with more individualised support provided to teachers who need it in using and analysing research methodologies. The action research model has potential for further development into an extended accredited post-graduate module at M level.

**Case study: On teacher learning [GiP10]**

*“Change needs to travel beyond our own classrooms. This work is embedded in an overall action research approach in our department which is fostering a culture of independent learning and personalised learning. What I would say to teachers is to use a variety of teaching and learning strategies in your class, even if that means getting out of your comfort zone ... show the students you enjoy your subject and are prepared to take risks. This is a big shift for teachers but if the result is ‘physics is not boring’ it is worth it!”*

### **7.2.3 Pupil Voice**

Listening to students and girls in particular has been an important aspect of this project and will make an enduring contribution to teachers' practice. Most teachers were overwhelmed by responses to questions about students' attitudes and concerns about science/physics teaching. Teachers were concerned by the extent of pupils', and girls' in particular, disengagement with the subject but also encouraged by the pupils' willingness to contribute their views.

Many teachers reported that they found pupil voice to be one of the most informative aspects of the project. The informal and qualitative discussions with girls in particular have had an impact on teachers' appreciation of the extent of girls' exclusion. Students and teachers have little control over the curriculum; however teachers used this opportunity to include students' contributions to the planning, implementation and evaluation of interventions to deliver the curriculum.

Another important aspect of pupil voice has been in the area of 'student peer learning' which has been expressed in a variety of ways in this phase. Some teachers have worked with young researchers explicitly as peer educators (mainly with other year groups) and others have opened up their learning and teaching methods to allow students to peer review and support learning in class. A few brave teachers extended classroom observation to include reviews by students as well as by colleagues. The experience of working with young researchers could be developed further to enable girls to define their own research questions to explore their own experiences of the physics classroom. This could include awarding of credit for students' action research projects and specific support and training with teachers to facilitate students' research.

The Girls into Physics project materials and the action research process has enabled the inclusion of pupil voice, which has resulted in appropriate focussing, implementation and evaluation of interventions. The legacy of this project is that teachers have experienced methodologies that help them access pupil voice and value that contribution. The experiences of teachers in this phase are illustrative of the benefits of listening to students and can be usefully promoted as an essential aspect of action research. If further funding allowed, additional student-led action research projects on girls' participation in physics could add to the body of knowledge of effective practice and policy.

**Case study: Young researchers on teachers and students as role models** [GiP Young Researchers]

*“Qualities of teachers as role models*

*Organised;  
Well planned lessons;  
Independent working in the classroom;  
Learn from them, copy behaviours.*

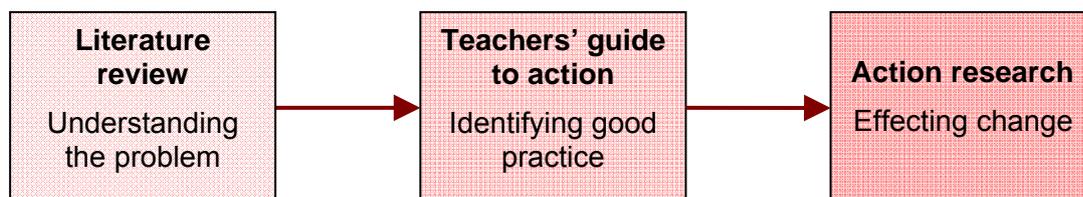
*Qualities of students as role models*

*Confident;  
Being friendly and building relationships;  
Being honest caring individuals;  
Being clear on objectives;  
Being at the same stages of learning;  
It is ok to say you don't know;  
Be encouraging.*

*The relationship between teachers and students really matter. We feel disappointed in ourselves if we don't work for our teachers”*

### 7.3 Conclusion

The three phases of the Girls into Physics programme are described in the diagram below:



Providing teachers with a guide to good practice is not enough to effect changes in schools. Teachers required time, space and support to **place the research in context** within their own schools and classrooms. Capturing and **listening to students' opinions and voices** was an important part of understanding the nature of inequalities in physics classrooms and most of the teachers did not have the tools or confidence to do this prior to their involvement in the project. In many instances, students as well as teachers were frustrated by perceptions of physics as difficult and boring. The wealth of information in the guide for action was overwhelming for some teachers, so support to **identify a starting point for change** was crucial to success. The most effective projects made a small but sustainable change, reflected on its impact then shared their findings with other teachers. For some teachers, the timeframe of the project was only long enough to contextualise the issue in their school and collect the opinions of students. They had only reached the point of identifying a starting point for change at the end of the second workshop. So appreciating that **the various steps in the process will take different amounts of time for different teachers** is important.

It is important to remember the scale of the issue that the Girls into Physics programme is addressing. The inequality between girls and boys in physics is long established and teachers are not the only influencers of students' attitudes towards the subject. Improving this situation is not a quick or straightforward process and every teacher of physics will need to take a slightly different approach in his or her classroom. Significant work in understanding the problem and identifying good practice has already been completed. However, arguably the biggest challenge is in making the necessary changes in classrooms, departments and schools for girls (and boys) to better engage with physics.

## 8. Recommendations

Recommendations have been constructed for three key aspects:

- *Recommendations for teaching practice* - advice aimed specifically at practicing teachers, divided by research cluster;
- *Recommendations for immediate action* - guidance for relevant organisations and individuals outside the classroom;
- *Possible developments of Girls into Physics* - potential areas of future research in the area.

### 8.1 Recommendations for teaching practice

These recommendations are a direct result of the teachers' experiences: they are recommendations to teachers from teachers. Further 'top tips' relating to teaching practice are provided in Appendix 13 as well as the Teachers' Guide for Action produced by Hollins et al. (2006). These recommendations have been divided by cluster for clarity.

#### 1. Recommendations - Learning and Teaching

- 1.1. Talk to students about how they feel about physics and to understand the context in your school and classroom
- 1.2. Get students onside to work with you to change this
- 1.3. Make sure students understand what physics is before linking it to careers or other areas of relevance
- 1.4. Create space in your lessons where discussions about the nature, purpose and relevance of physics can take place

#### 2. Recommendations - Classroom Management

- 2.1. Ensure interventions are appropriately timed: consulting students during the process will help maximise the chance of success
- 2.2. Sharing good practice in school and beyond is valuable; including students' voices reinforces this

#### 3. Recommendations - Careers

- 3.1. Careers advice - including that specific to physics - should be integrated throughout secondary school, not only at specific points
- 3.2. Teachers should be encouraged to become aware of their students' career aspirations - they will almost certainly be surprised by the results, which will greatly help to inform their teaching
- 3.3. The awareness of and access to existing physics-related careers materials should be improved, especially amongst non-specialist teachers

- 3.4. Relevant links to careers should be highlighted throughout normal physics teaching, including activities where the students seek their own information

#### **4. Recommendations - Progression**

- 4.1. Incorporate examples of appropriate role models at all stages of progression, from the primary / secondary transition right through secondary school and into University as well as later professional careers
- 4.2. Link the physics covered to wider social relevance and interest

#### **5. Recommendations - Workforce**

- 5.1. Specialist teachers can work with non-specialists to build their confidence and suggest strategies
- 5.2. Consider the balance of factors that create a good physics teacher and don't prioritise specialist knowledge above all else

#### **6. Recommendations - Culture and ethos**

- 6.1. Use interventions that the whole school can see or get involved in

### **8.2 Recommendations for wider immediate action**

The recommendations within this section are applicable to a wider audience of organisations and individuals outside the school environment, including the Department for Children, Schools and Families, the Institute of Physics and the Science Learning Centre network.

#### **Two-day programme model should be continued**

The format of the Girls into Physics sessions was well received by teachers and proved successful in ensuring their deeper involvement. Key factors to this success were the inclusion of two separate workshops, separated by an appropriate length of time for intervention delivery and reflection. Many teachers acknowledged that without the second 'reporting' workshop their projects probably wouldn't have happened. The financial support offered (which provided cover for the teachers during the programme) was also crucial to their ability to be part of the programme.

#### **Appropriate application of the Red Books**

Whilst the Red Books (Murphy and Whitelegg, 2006; Hollins et al., 2006) proved extremely useful at informing teachers of previous research and best practice, it is crucial that the data and methodologies contained within are not followed blindly. For example, the questionnaire within the second Red Book (Hollins et al., 2006; pp27-29) should be used with caution. It is more important to gather school-based data that provides appropriate context (attainment, progression etc.) to inform the teacher's specific project rather than carry out the full questionnaire analysis within each school.

#### **Gender aware teaching to be incorporated into standard CPD**

Gender aware teaching was a relatively new concept to many teachers however it is a topic that could be incorporated into many existing CPD programmes. This should include a focus on using pedagogy to support girls (and boys) succeed in physics rather than focus on single sex groupings.

### 8.3 Recommendations for future research

The results of this project identified three clear areas for future development of the Girls into Physics programme:

#### Possible developments of Girls into Physics

A phase 3 version of this project should incorporate the following elements:

- Develop **students' involvement** in research. Ensure pupil voices are incorporated during reflections on impact, not just teachers' perceptions of impact. Support student- led projects.
- The **timing** should be carefully chosen to allow teachers to incorporate their intervention at the beginning of the academic year. Many of the Phase 2 interventions had reduced impact, arguably due to the intervention being perceived as an 'interruption' to the students' normal routine. By starting the year with the new methodology this issue would be avoided. Some teachers also argued that beginning the project in June would be best, in order to take advantage of additional timetable space once examination year groups have departed.
- The **action research** methodology worked well in encouraging teachers to reflect upon their practice. Phase 2 of this programme demonstrated that large scale questionnaires and data analysis are useful but only when there is time to inform the development of a small scale action research project.
- Teachers should be strongly encouraged to keep their projects **short and simple**, rather than aim for something overly ambitious in the first instance. For greatest success this should focus on a small achievable change and involve students directly in reflecting both on potential mechanisms for achieving change as well as how any interventions have affected them.
- A **follow-up project with the same teachers** would be very valuable - many teachers expressed frustration during the reporting workshops that their interventions were still in the early phases, therefore the full impacts were not yet visible. Phase 2 in many cases merely scratched the surface; providing the same teachers with an opportunity for further development and reflection would be invaluable.

#### Single-sex groupings

Further research in this area should be commissioned. Single-sex teaching was not one of the recommendations of the Red Books (Murphy and Whitelegg, 2006; Hollins et al., 2006) however many teachers (and schools) were convinced that single-sex groupings were decisive positive factors in encouraging female progression in physics. In the experience of the External Research Team, some teachers even believed it had a positive effect when the research data proved otherwise. A research and practice briefing dealing with the specific issue of single sex groupings and physics (including evidence of both short and longer term impacts, and how to manage single sex groupings within class) would be very beneficial in clarifying the matter.

### **Analysis of longer-term impacts**

The short-term nature of the project meant that the full impact of this work has not been assessed to date. A review of selected projects from Girls into Physics Phase 1 and Phase 2 in four years time to investigate levels of attainment for both boys and girls and motivation and take up of Physics post-16 by girls may prove insightful.

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## Appendix 1

### List of participating schools

#### EE Schools

Bottisham Village College  
Comberton Village College  
Sawston Village College  
Mayflower High School  
The Herts & Essex High School  
Debenham CEVC High School  
Soham Village College  
The Meridian School  
Sweyne Park  
The Helena Romanes School and  
Sixth Form Centre

#### NE Schools

Tanfield Comprehensive School  
St Anthony's Catholic Girls' School  
Richmond School  
St Michaels RC School  
Monkseaton Community High School  
Carmel Roman Catholic College

#### SW schools

Torpoint Community College  
The Ridings High School  
SMRT  
Huish Episcopi  
Hayesfield school  
South Dartmoor Community College  
Helston Community College  
Launceston college  
Hele's School  
Oldfield School in Bath

#### Y&H Schools

Allerton Grange  
Mount St Mary's  
Balby Carr  
Hemsworth  
Ossett  
Rawmarsh

#### SE Schools

Hounslowdown School  
The Cooper School  
Mountbatten School  
Woodlands Community College  
Redbridge School

#### WM Schools

St John Fisher RC High School  
Sutton Coldfield Grammar School for girls  
Newport Girls' High School  
Moreton Community School  
St Edmund's Catholic School  
Rugby High School  
Smestow School  
New College Telford  
Paulet High School

#### NSLC Schools

Plumstead Manor School  
The Warren Comprehensive School  
Buttershaw High School  
Oakbank School  
Heworth Grange Comprehensive School  
Healing School, A Specialist Science College  
The Purbeck School  
Perins School  
Woodlands Community School  
Tunbridge Wells Girls' Grammar School  
The Banovallum School, Horncastle  
Holy Trinity Cofe Secondary School, Crawley  
Portlethen Academy

## Appendix 2

### School allocations into clusters

[GiP#]	Primary cluster	Secondary Cluster	Tertiary Cluster
1	Learning and Teaching	Classroom Management	Young researchers (consultative group)
2	Learning and Teaching	Classroom Management	Young researchers (peer teaching)
3	Classroom Management		
7	Single Sex (Classroom Management)		
10	Learning and Teaching	Classroom Management	Ethos
13	Learning and Teaching		
14	Careers and Guidance		
15	Learning and Teaching		
16	Single Sex (Classroom Management)		
17	Careers and Guidance	Ethos	Learning and Teaching
20	Careers and Guidance		
24	Ethos	Careers and Guidance	
29	Careers and Guidance		
30	Learning and Teaching		
31	Learning and Teaching		
32	Learning and Teaching	Careers and Guidance	
33	Learning and Teaching		
39	Learning and Teaching	Ethos	
40	Careers and Guidance		
43	Careers and Guidance		
48	Classroom Management		
50	Single Sex (Classroom Management)		
51	Learning and Teaching	Classroom management	
52	Careers and Guidance		
53	Single Sex (Classroom Management)	Learning and Teaching	
55	Progression routes (primary project)	Learning and Teaching	Classroom management
56	Progression routes		
57	Learning and Teaching (partly Single Sex)	Careers and Guidance	Workforce
60	Careers and Guidance		
61	Classroom Management		
63	Learning and Teaching		
64	Workforce (specialist teachers)		
65	Progression Routes	Careers and Guidance	Ethos
67	Progression Routes		
68	Learning and Teaching	Classroom Management	
69	Progression Routes		
71	Careers and Guidance		
72	Progression		
73	Classroom Management (Single Sex)		
74	Data analysis		
75	Single Sex (Classroom Management)		
76	Careers		
77	Learning and Teaching	Classroom Management (Single Sex)	
78	Single Sex (Classroom Management)	Learning and Teaching	
79	Learning and Teaching		
80	Learning and Teaching		
81	Learning and Teaching		
83	Data analysis		
85	Classroom Management	Learning and Teaching	
86	Data analysis		
87	Careers and Guidance	Workforce	
88	Careers and Guidance	Learning and Teaching	Classroom Management (Single Sex)
89	Learning and Teaching		
92	Workforce (specialist teachers)		
93	Learning and Teaching		
97	Learning and Teaching	Workforce	
98	Careers and Guidance		
99	Careers and Guidance		
100	Careers and Guidance		
101	Careers and Guidance		

## Appendix 3

### Teachers' project summaries

*This Appendix contains brief summaries of each of the individual teachers' projects. The details have been taken from the final reporting templates and are therefore in the teacher's own words. The projects are provided in order of their chosen cluster (as mapped onto the Theory of Change, see Figure 4). Some numbers are missing due to some teachers not completing the entire programme; therefore their data is unavailable for analysis.*

#### Learning and Teaching

21 projects in total

**[GiP1]** Changing questioning and answering techniques to improve confidence in girls. The students decided after their initial questionnaire that they would like more time to think about questions and ways to respond that didn't put them on the spot. The young researchers felt this was hindering girls, claiming that the girls were more worried about losing face than the boys and as a result were less likely to offer their ideas and alert teachers when they were stuck.

**[GiP2]** I chose making physics more relevant and fun as the focus of my project and worked with a small group of young researchers in Year 10. They peer taught a Year 8 class using active learning methods and making physics more relevant to girls' interests.

**[GiP10]** A planned series of 8 lessons was the basis for this project to test:

- an increase on personalised learning within a framework of fun activities.
- classroom management to facilitate student led learning
- changing the current ethos of a teacher led classroom

Include examples that are typically girl friendly within the context of OCR module P2 Radiation and Life. Use learning styles generally preferred by girls; project work, small group discussion. A choice element within lessons as to the content focus, method of working and resources used. Use strategies to encourage talk; drama strategies taken from 'Evolve' a drama manual for science teachers, Bidi Iredale.

**[GiP13]** I used analogies to explain abstract science concepts, and encouraged classes to compose their own to help understand the science better. Judging of others' work was encouraged and constructive criticism promoted to reach an agreed class analogy.

**[GiP15]** After teaching a concept, I gave groups of students 5-10 minutes to discuss their understanding and ask questions of each other in order to assess their learning. Each group reported back to the class, either verbally (via a spokesperson) or by a role play.

**[GiP30]** I have made use of more group discussion before giving answers, and also use of mini whiteboards to feedback responses (I now use these a lot in all my science lessons). In addition I have experimented with Senteo voting software as an assessment technique. I have tried to use more 'stories' and examples that are related to the students' lives, especially when introducing topics, and to come up with ways of making concepts clear before introducing equations (e.g. I thought up a kinaesthetic way of getting the students themselves to work out the wave equation). In addition I have observed a maths lesson and discussed ways of approaching using equations with one of the maths teachers in the school. I now put much less emphasis on rearranging equations, getting students to substitute numbers in first - which they seem to find easier.

**[GiP31]** I introduced some learning tools - mini white boards. I chose a subject that students found uninteresting - stars and tried to encourage them to become more interested in the subject.

**[GiP32]** After the SATs examination all year 9s were involved in producing career posters. The type of activity that they carried out depended upon their set. Top set had to research science careers and a career that physics could help them in. Set 2 were looking at science careers and a career that science would help them. Set 3 and 4s were researching careers that science would help them with.

My top set year 9s were involved in planning and delivering a lesson to year 2 pupils after their SATs examination. They were given the KS2 physics syllabus and had to design a lesson from it.

I lectured at Anglia Ruskin University for a day. Topics included 14 - 19 curriculum, what makes a good science teacher, NQT year, interactive activities and Encouraging Girls to Study Physics further = based on what I found out during Phase 1.

**[GiP33]** I limited my use of technical terms until the basic concept/idea had been established. I also encouraged the use of non-scientific terms in oral and written answers from students to encourage participation by the girls. I also increased the use of mini-whiteboards as a way of giving feedback in a non-judgemental way.

**[GiP39]** I compared my starters with those developed by girl students from my Physics class. I set up a focus group of year 10 girls from my Physics class to discuss issues they had with Physics.

**[GiP51]** We bought some nice, new shiny equipment to use in the teaching of velocity, acceleration, forces, motion, etc and introduced this into lessons. This included trolleys, tracks, light gates and timers. We also ensured that girls were given the first opportunity to use this equipment.

**[GiP57]** Will single sex lessons raise attainment? How do students rate science (in particular physics) - both in attainment and enjoyment?

- more observations within the department
- more training within the department
- single sex SATS booster classes
- careers club - with a science bias in development
- science club - introducing at KS4 as well as continuing the established group at KS3

**[GiP63]** Joining the school my U6 set was six strong and my L6 was only 3. The following year the U6 was only 1. The L6 numbers were up to 8. This year 5 of those stayed with Physics to A level. The L6 group is now 14. This is after implementing some Phase 1 ideas and re-surveying the group. Some positive impact has been made although it is still not where I would like it. Using Survey Monkey, a follow up attitudinal-based survey was conducted looking at provision and approaches adopted by my teaching helped or hindered viewing A level Physics as a post-16 opportunity for them

**[GiP68]** After being very confident that my classroom interactions were around 50% between boys and girls, I decided to check that my assumption was correct. After being surprised by the results, I decided to look at gendered and non gendered examples and see the effect on answering questions.

**[GiP77]** We have changed the order of the units so that they do not repeat topics all the time. We introduced more practicals into lessons and tried to relate physics more to everyday life. I have also changed the way physics practicals are done - girls now work together.

**[GiP79]** I conducted my research by teaching two different lessons on refraction to two Year 7 classes. One class received the normal lesson or scheme of work and the other I taught from the Biological / relevant start point of the eye. I compared data on enjoyment / understanding / and attainment data for the two classes. Attainment was compared with 3 selected students (high, middle and low achieving) with similar year ending assessment scores.

**[GiP80]** Used more practicals to teach P2 (Gateway) and students did very little written work. I provided the students with a questionnaire before and after the intervention. 58% said it was boring before and this had changed to only 17% thinking it was boring after.

**[GiP81]** Looking at how lesson style affects learning and confidence using life related topics. To alter / confirm teaching methods used at school and to inspire overall teaching and learning.

**[GiP89]** The number of girls studying advanced level physics was falling, with a similar pattern for girls following further study or a career. A series of starter activities were produced for the Forces module in year 11 21C science, which built the context of the learning and set a challenge for the pupils to consider prior to learning the content which was then used to solve the challenge. Also incorporated:

- No hands-up questions
- Valuing & developing girls responses
- Less demo more problem solving practicals

**[GiP93]** I was concerned that our top four modular science groups were being taught physics by non-specialists who lacked any enthusiasm or confidence in the teaching of the physics - this was being passed on to the girls and this years results from yr 11 leavers show that physics is significantly behind the other 2 sciences. Being the only physicist at the time it would have been impossible for me to teach the physics to all these classes. If I couldn't reach the students by teaching them myself I was going to have to write a SOW that excited the teacher and gave them confidence to teach the physics as an exciting, interesting subject that actually in reality is no harder at GCSE than the other 2 sciences.

The scheme of work for forces and motion was completely revamped. It contained YOUTUBE clips from top gear, new school resource called clip bank and money spent on new equipment for the scheme of work. Practicals have been written in detail and have even been recorded on film. Suitable discussion questions suggested with information on correct terminology that needs to be used.

**[GiP97]** I inherited a middle ability Yr9 class who were unruly and totally demotivated by science (having been taught by a string of supply teachers). In my opinion most of the group were intelligent and had the potential of grade 6 in their science SAT. Most of the group were indicated level 5 or below. A change was needed if they were to succeed and once again enjoy science.

I altered my teaching and learning strategy for one module. Class had to complete a Physics case study. Changed plan to title: Physics is the most important subject taught in school because it has had the most beneficial effect on human kind! Discuss. Students were to create their case study as a podcast to be presented to the rest of the group.

## Classroom Management

4 projects in total

**[GiP48]** I used different groupings with a top set KS4 class. The arrangements for the groups were either single or mixed sex. They also were either arranged alphabetically or by friendship groups. Both of these led to mixed ability groups.

**[GiP61]** In the recent outstanding Ofsted inspection, one of the points for action was that learners are sometimes too passive. Informal observations within the classroom suggested that some girls relished group work and contributed enthusiastically, sometimes dominating a group and leaving little space for others to contribute in a meaningful way. Other girls were content to sit back and take little part. It was hoped that assigning roles within groups would redress this balance and allow all girls to participate in and learn from group work.

There was a change to strategies for group work throughout the whole of year 8 to achieve higher levels of participation from all girls. The class teacher decided upon and assigned individual roles to girls for each piece of practical and group work.

**[GiP85]** I increased the amount of group activities I used within my lessons and gave more opportunities for students to talk about their findings. For example, instead of all students investigating each factor, I split the class into groups with the aim to investigate one factor, and present the results to the class. I used A5 whiteboards for group responses and encouraged students to respond to other students' comments.

## Classroom Management (Single Sex)

7 projects in total

**[GiP7]** Change within classroom by further attempting single gender working groups during any group work task with both of my year 10 classes and by allocating roles within groups to ensure a fair distribution of the tasks that groups must complete. This was carried out on group work tasks with one class over a period of about 8 lessons.

**[GiP16]** I originally had the students sitting in a mixed seating plan decided by me at the start of the year. At the start of my intervention project, I rearranged the seating plan so that the students were arranged in six single sex groups of five pupils. During all activities, the students completed the work within their groups on their tables. The styles of work completed included practical, discussion, worksheet based and revision activities.

**[GiP50]** I briefly explained what each project involved, reminded them what physics, chemistry and biology involved ensured further instructions were on the worksheets and pointed out some phys, chem. & boil topics studied so far (at KS3). Two weeks was set aside to complete this task.

**[GiP53]** Would girls benefit by being taught in single sex groups especially in practical sessions to allow them more opportunities to take the lead? Would this then lead to an improvement in attainment and ultimately a greater take up in Physics post 16?

Questionnaires were given to the more able Y10 girls to ascertain their attitude to science. The intervention was focussed on Year 8. In one half of the cohort groups continued to be taught as before. In the other half the groups were divided into single sex groups. All teachers were asked to follow the same lesson plans to the extension of the intervention.

**[GiP73]** Introduce a culture of 'Yes I can!' in the classroom. Group girls together to do practical activities and encourage them to give both oral and written feedback. Create an environment where girls will be willing to learn Physics, willing to take part in all practical activities and succeed in Physics.

**[GiP75]** I undertook the analysis of Y10 module test results comparing the mixed gender groups with the single sex groups to test my hypothesis that the relative success of the single sex groups could be accounted for by the fact that mutually distracting boys and girls are separated and unable to distract to the detriment of each others' learning. I wanted to also test the competing explanation that is that girls perform better in Physics away from the company of dominating boys and the association of physics with maleness.

**[GiP78]** I looked at putting Year 10 girls into single sex sets. Questionnaires for all years looking at why they don't want to do Physics A Level and general feelings about Physics.

## **Progression**

6 projects in total

**[GiP55]** Why do girls lose interest in science between KS2 to KS3? How can we keep interest from KS3-KS4? Faculty development plan focused on KS2 - Ks3c transition. Improving links with feeder schools. Providing a role model for girls by focusing female teachers with specific groups.

**[GiP56]** Broadly speaking my research was centred on the question "Why don't girls opt for physics at A Level? After a detailed analysis of students' responses to a completed questionnaire on science, I decided to focus on raising the profile of physics and the opportunities afforded by an A level in Physics. During the last term of the year 2007 - '08 my focus was on the Year 10 Girls. Initially a questionnaire was developed and given to all higher ability students, including the boys, looking at various aspects of science and physics in school, and perceptions of the reasons for and progression using science / physics. Based on this research a group of 24 Girls were identified who have the academic ability to do Physics at A' level, but not the inclination.

**[GiP65]** Constantly looking for opportunities to integrate careers guidance into lessons at relevant points e.g. designing crash test cars leading to opportunities to discuss engineering / design; earthquakes leading to role of Geo-physicists.

Looking for links to get in external speakers.

Looking for opportunities to organise visits to workplaces relevant to our GCSE syllabus e.g. medical physics visit to local hospital centre to enhance the medical physics aspect of the new GCSE physics syllabus.

Looking for posters showing science careers.

**[GiP67]** To determine which aspects of successful schools and Science Status initiatives are most influential in recruiting girls.

- Raise awareness of physics issues with Careers adviser.
- Develop Physics careers board
- Raise awareness with Maths to emphasise links when discussing A level.
- Raise awareness to whole staff of issues and can do culture necessary.
- Raise awareness to all Science teachers of issues so they can develop cross curricular links.
- Develop and highlight Medical Physics coursework link at AS level.
- Make open evening presentation available on school VLE
- Deliver A level info and taster lesson to Yr11 at October half term.
- Develop open Evening presentation to include more details about grades and careers.

**[GiP69]** I looked at the data for the numbers of students expressing an interest in Physics and those signing up for the subject.

I ran a 1 hour “Girls Into Physics” session for visiting Yr 10 students as part of a Science Day at college. I got together a panel of women consisting of our careers officer, 2 AS students, an astronomer, an environmental scientist, and myself ( all female). We had an informal discussion about studying Physics at AS level.

**[GiP72]** To identify why few girls from 11-16 chose AS and A2 Physics. More information on which careers require science before option choices in KS3/KS4. Using AS students as Physics Ambassadors in Year 10/11.

## Careers

15 projects in total

**[GiP14]** I designed a questionnaire and gave it to the students. From the initial responses it was clear that the students were not sure what jobs a physics qualification could lead to. I decided to do some action that involved emphasizing the options a qualification gives and the various career options that would be open to students with a physics qualification.

**[GiP20]** In place of their normal science lessons, year 9 and 10 students in sets 1 and 2 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. The lessons were led by one of two female physics teacher, both of who have worked in physics related careers prior to teaching. The lessons were three-part, with a research-based main activity aimed at investigating career pathways accessible with a physics degree or A level.

**[GiP29]** We used internet research to look at how physics can help with chosen careers. IOP website was very useful in this task. Pupils then produced posters and a few gave two minute talks to the rest of the group about how physics can help. Boys in the group were also included in this.

### **[GiP40]**

1. Dedicated and regularly updated “Women in Physics” careers board.
2. Local setpoint “Girls in Physics day” to introduce the girls into various types of careers in Physics.
3. Starter videos of “Women in Physics” linked to topics.
4. Linking of salary progression to the study of Physics
5. Trips to various companies with talks on the relevance of Physics

**[GiP43]** I started the GCSE course with a presentation of possible Physics careers and made lesson plan changes, introducing computer games to get an interest. At the start of each Physics topic taught I would make a short movie presentation showing where that topic can be used in a career. I made some of these careers very appealing to girls e.g. light topic I showed an art career, night club lights designer and presentation. Then we did the main physics lesson and reviewed how it fits to the career in the plenary.

**[GiP52]** I asked the pupils what are their perceptions of physics and physicists and how do you much do you understand their jobs? I also investigated their responses to the idea of how likely are they to use physics in their future employment. More emphasis on the roles of scientists and how the concepts that they are being taught match the job opportunities. I also worked closely with the work experience coordinator to encourage more girls to take up physics based placements or engineering placements. The careers teacher has also begun using more diverse concepts in the idea of what actually is a scientific career.

**[GiP60]** I have become better prepared with information about careers and guidance about courses for girls with an interest in physics. I have looked for more opportunities within the schemes of work to discuss the relevance of physics in a range of careers. I am improving links with universities, and have taken the lower sixth to Salford University Physics Department to meet female physics academics and postgraduates. A female speaker from Birmingham university has been arranged. Year 9 girls have attended a "Girls Day Out" at the local Science Learning Centre.

**[GiP71]** Heard of girls into physics project via ptnc and realisation that although we had girls in A level physics group, they had been mainly from the partner school in our shared sixth form, why weren't we recruiting more girls? Anecdotal evidence of poor advice re: subject choices at A level prompted the focus on careers advice.

**[GiP76]** Three questionnaires were used and a one hour activity session.

- 1) To get an idea of how girls see Physics in the classroom, to judge their awareness of the subject within the curriculum and how Physics can apply in everyday life and future careers.
- 2) To get an idea of the type of activities girls enjoy in science class, how they prefer to work in the classroom environment and how this affects their enjoyment of Physics.
- 3) To establish what challenges teachers are facing when teaching Physics to pupils.

**[GiP87]** IoP GiP staff survey prompted concerns regarding guidance / careers in Science Department. Anecdotal evidence in prep room also causes concern at times. Evidence from student questionnaire ref enthusiastic and interesting subject teacher needed for 'good' lessons also confident with practical work.

- 3 lessons spent on carers work with my Yr 9 class

- lack of time / other more 'important' items on agenda for science department meant that my planned INSET did not take place

**[GiP88]** Few girls choose to study Physics at A level or IB Higher despite studying GCSE Physics in an all girls class. In the majority of lessons to my all girls Physics GCSE class in yr 10/11 I included information about the applications of that area of Physics.

**[GiP98]** A group of 8 gifted and talented students including 3 girls visited a satellite design/engineering company and spoke to young scientists about their careers and the work they did. Pre- and post visit questionnaires were used to evaluate whether exposure to this experience would influence course and career options in future.

**[GiP99]** I have conducted several interviews and students have completed a questionnaire. I reviewed progress in June when I posed similar questions to year 9 boys as well as girls.

**[GiP100]** A display was produced showing details about a range of possible careers that Physics qualification may lead to. The posters included details re: the job title, job description, the importance of the job to others, required qualifications, the initial salary and potential future salary, travel opportunities that may arise.

**[GiP101]** Careers input in Sixth Form Information Evening, Taster Morning and in lessons

## **Ethos**

1 project only

**[GiP24]** Worked with girls to create a large display in the school dining room called Physics: the big picture. The display was researched and created by a class of students and highlighted the linkages between different areas of physics and potential physics-related careers.

## **Relevance**

1 project only

**[GiP17]** In all years, I tried to show the relevance of Physics to the “outside world”.

1. Year 7 had a visit from an ICT wizard.
2. Year 10 and year 11 have been to see up to date applications of modern research to the workplace.
3. Year 9 did a research project on suitable careers following a further education course in physics.
4. Transferable skills used in science have been highlighted.
5. Less able year 10 students attended a course focusing on Applied science at CRC in July.

## **Data sets**

3 projects in total

**[GiP74]** I chose to research student perspectives in a top set Year 9 class that have taken GCSE Science this year. Data was collected in the form of a questionnaire, which was specifically tailored to investigate the factors (relevance, enjoyment of the subject, interest in the subject, difficulty of subject, how students rate themselves, how students perceive teachers rate them).

**[GiP83]** How do girls performance compare to that of boys on the Physics components of GCSE. I will look at data on a spreadsheet and easily sort by gender, topic, ability, set etc to look for trend, patterns etc. Sample will be Year 11 students from 2005, 2006, and 2007.

**[GiP86]** The purpose of this research was to discover if students attitudes to science in general and their reasons for choosing the disciplines followed. The questionnaire used was based on the IOP Girls into Physics questionnaire.

## **Workforce**

2 projects in total

**[GiP64]** Talk to girls about their attainment within physics topics and record their responses and explanations into the non advancement of girls into further physics.  
Action - Using sets 1 and 2 in year 10 that are currently taught by a Biochemist and a Physicist respectively, teach physics topics using Physics specialist with both groups.

**[GiP92]** Team taught a Year 9 top set for the topic of forces. Their teacher lacked confidence in delivering physics topics. The teacher concerned had not taught physics to a top set in Year 9 and wanted support. I was the only specialist physics teacher in the school and wanted to see how effective team teaching would be. Was it worth doing with other staff?

## Appendix 4

### Indicators Toolkit

Indicators are a way of identifying changes that might occur as a result of interventions. Thinking about them before the intervention takes place helps researchers anticipate the changes so as to measure them more effectively. However researchers also need to be aware that some other changes may occur that are not anticipated, which are also important to look out for.

The indicators listed in this document are designed to guide the questions that the action research projects will ask in each of the six research clusters. There are many ways that these and other indicators can actually be measured, for example through observation, or a questionnaire, or through interviews and discussions with students.

This is not intended to be an exhaustive list. Teachers may well identify other indicators that could be used to show whether or not interventions have made a difference in the physics classroom, however we hope this provides a useful starting point. A single action research project could focus on one indicator, or it might include several.

The indicators are split up according to who or what will experience the change to be measured. The three groups initially identified are **learners** themselves, **teachers** and the **department or school**. For learners and teachers, each indicator focuses on awareness or knowledge (cognitive), attitudes and feelings (affective) or behaviour.

#### Learners

- Increased attainment in physics end of project tests (cognitive)
- Girls' expectations of success in physics matches that of other subjects (cognitive)
- Students report improved understanding of physics concepts (cognitive)
- Raised awareness of linkages between different physics topics (cognitive)
- Greater awareness of progression routes from physics (cognitive)
- Increased awareness of how physics is valuable in different careers (cognitive)
- Students feel teaching is better tailored to their individual learner needs (affective)
- Greater appreciation of how physics fits in with the world (affective)
- Increased uptake of physics at AS and A2 (behaviour)
- More girls state intention of pursuing physics post-16 (behaviour)
- Girls and boys contribute to all aspects of the learning experience (behaviour)
- Students report higher levels of involvement in class (behaviour)

## Teachers

- Increased awareness of the types of careers that interest girls (cognitive)
- Increased awareness of physics progression routes (cognitive)
- Raised gender awareness around girls' competence in physics (cognitive)
- Raised awareness of gendered dimension to teaching and learning (cognitive)
- Encourage and expect girls and boys to take physics equally (affective)
- Teachers feel more confident and competent teaching physics to engage girls (affective)
- Developed practices for introducing careers into lessons (behaviour)

## Department / school

- Raised awareness of physics progression routes and physics-related careers for staff responsible for IAG
- Move from expectation that post-16 physicists will be selected to expectation that all can participate
- Effective gender-aware classroom management and teaching and learning strategies in other departments trialled; success of new approaches in physics classrooms shared across dept and school
- Increased level of gender awareness within department

## Indicators for the research clusters

The remaining sections of this document look at which indicators are appropriate for use with projects in each of the six research clusters. Again, this is designed as a guide only so other indicators can be used where appropriate.

## Increasing the uptake of physics post-16

This is the key aim of the project, so these indicators cut across all of the six clusters and should be measured whenever possible.

Learners	Teachers	Dept / school
<ul style="list-style-type: none"><li>• Increased uptake of physics at AS and A2</li><li>• More girls state intention of pursuing physics post-16</li></ul>		

## Careers and guidance

This cluster focuses on interventions that will highlight the value of physics to a wide range of scientific and non-scientific careers. Physics education research has indicated that girls are more likely to link subjects to careers than boys, so making these linkages could help girls feel that physics is more relevant to their futures.

Learners	Teachers	Dept/school
<ul style="list-style-type: none"> <li>• Physics seen as more relevant</li> <li>• Increased awareness of how physics is valuable in different careers</li> </ul>	<ul style="list-style-type: none"> <li>• Increased awareness of the types of careers that interest girls</li> <li>• Increased awareness of physics progression routes</li> <li>• Developed practices for introducing careers into lessons</li> </ul>	<ul style="list-style-type: none"> <li>• Raised awareness of physics progression routes and physics-related careers for staff responsible for IAG</li> </ul>

## Progression routes

This cluster of projects will look at how teachers and careers staff within schools can promote the range of routes into physics post-16. The assumption here is that placing physics in the context of a progression route, girls will see its relevance to their educational and career goals.

Learners	Teachers	Dept/school
<ul style="list-style-type: none"> <li>• Greater awareness of progression routes from physics</li> <li>• Greater appreciation of how physics fits in with the world</li> <li>• Increased awareness of how physics is valuable in different careers</li> </ul>	<ul style="list-style-type: none"> <li>• Increased awareness of the types of careers that interest girls</li> <li>• Increased awareness of physics progression routes</li> <li>• Developed practices for introducing careers into lessons</li> </ul>	<ul style="list-style-type: none"> <li>• Raised awareness of physics progression routes and physics-related careers for staff responsible for IAG</li> </ul>

## Ethos

Interventions in this cluster will identify ways to promote an ethos of 'physics is for everyone' and positive perceptions of physics in school. Research has indicated that girls are less likely than boys to feel competent in physics (although their attainment shows that this belief is unfounded). Through promoting a positive ethos in relation to physics, girls' physics self-concept (i.e. how they see physics as something relevant to them that they are good at) can be improved, thereby increasing uptake post-16.

<b>Learners</b>	<b>Teachers</b>	<b>Dept/school</b>
<ul style="list-style-type: none"> <li>• Increased attainment in physics end of project tests</li> <li>• Girls' expectations of success in physics matches that of other subjects</li> </ul>	<ul style="list-style-type: none"> <li>• Raised gender awareness around girls' competence in physics</li> <li>• Encourage and expect girls and boys to take physics equally</li> </ul>	<ul style="list-style-type: none"> <li>• Move from expectation that post-16 physicists will be selected to expectation that all can participate</li> </ul>

### **Learning and teaching**

Physics education research suggests that girls are more interested than boys in the social context of physics and how physics can be used to help people. This cluster explores how gender awareness regarding the content and examples used in physics lessons could contribute to physics being taught and learned in a way that is accessible and engaging for girls.

<b>Learners</b>	<b>Teachers</b>	<b>Dept/school</b>
<ul style="list-style-type: none"> <li>• Girls and boys contribute to all aspects of the learning experience</li> <li>• Students report higher levels of involvement in class</li> <li>• Students report improved understanding of physics concepts</li> <li>• Raised awareness of linkages between different physics topics</li> <li>• Students feel teaching is better tailored to their individual learner needs</li> </ul>	<ul style="list-style-type: none"> <li>• Raised awareness of gendered dimension to teaching and learning</li> <li>• Teachers feel more confident and competent teaching physics to engage girls</li> </ul>	<ul style="list-style-type: none"> <li>• Effective gender-aware classroom management and teaching and learning strategies in other departments trialled; success of new approaches in physics classrooms shared across dept and school</li> </ul>

## Classroom management

Interventions in this research cluster will explore how classrooms can be managed to promote girls' involvement in group work. The assumption here is that teachers will already be adopting learner-centred teacher practices, so interventions will focus on additional practices that can be adopted to engage girls.

Learners	Teachers	Dept/school
<ul style="list-style-type: none"> <li>• Girls and boys contribute to all aspects of the learning experience</li> <li>• Students report higher levels of involvement in class</li> <li>• Students report improved understanding of physics concepts</li> <li>• Raised awareness of linkages between physics content</li> <li>• Students feel teaching is better tailored to their individual learner needs</li> </ul>	<ul style="list-style-type: none"> <li>• Raised awareness of gendered dimension to teaching and learning</li> <li>• Teachers feel more confident and competent teaching physics to engage girls</li> </ul>	<ul style="list-style-type: none"> <li>• Effective gender-aware classroom management and teaching and learning strategies in other departments trialled; success of new approaches in physics classrooms shared across dept and school</li> </ul>

## Workforce

This cluster explores how the physics teaching workforce within a school can be developed and deployed to give girls a greater level of access to specialist physics teachers. Educational research tells us that girls are more vulnerable to the detrimental effects of weak physics teaching, so interventions in this cluster will attempt to address this.

Learners	Teachers	Dept/school
<ul style="list-style-type: none"> <li>• Students report improved understanding of physics concepts</li> <li>• Greater appreciation of how physics fits in with the world</li> </ul>	<ul style="list-style-type: none"> <li>• Teachers feel more confident and competent teaching physics to engage girls</li> </ul>	<ul style="list-style-type: none"> <li>• Increased level of gender awareness within department</li> </ul>

## Measuring the indicators

A toolkit containing resources to measure these indicators is provided on the **Girls into Physics** community on the SLC portal. Potential methods could include (but may not be limited to):

- Attitude scales
- Interviews
- Focus groups
- Teacher self-evaluation
- Teacher peer evaluation
- Diaries / journals
- Young researchers
- Video diaries
- Blogs
- Graffiti walls
- Discussions in staff meetings
- E-surveys

## Appendix 5

### Workshop 1 Suggested Schedule

9.30 - 10.00	Registration and coffee
10.00 - 10.15	Introduction to the project <ul style="list-style-type: none"> <li>○ Action Research and the Evaluation</li> <li>○ GTC and TLA (documents in pack)</li> </ul>
10.15 - 11.15	Girls into Physics - group activity <ul style="list-style-type: none"> <li>○ Attitudes of girls</li> <li>○ Concerns of teachers</li> <li>○ What works?</li> <li>○ Reflection - where is your school?</li> </ul> (activity to sort into issues, practice and next steps) <ul style="list-style-type: none"> <li>○ Refer to Literature and Research Clusters and Research Questions (hand out / refer to portal resources)</li> </ul>
11.15 -11.30	Coffee
11.30 - 12.15	Introduction to action research - pair activity <ul style="list-style-type: none"> <li>○ Definitions</li> <li>○ Research methods</li> <li>○ Contribution of qualitative methods</li> </ul> (refer to Teachers Guide, Toolkit on portal)
12.15 - 13.00	Action research resources - individual use of portal - laptops / PCs needed <ul style="list-style-type: none"> <li>○ Using the portal</li> <li>○ Self-evaluation checklist</li> <li>○ Evaluation toolkit</li> <li>○ Other resources e.g. PEEP</li> </ul>
13.00 - 13.30	Lunch
13.30 - 14.15	Brainstorming interventions - group and individual planning
14.15 - 15.15	Clarifying details of interventions <ul style="list-style-type: none"> <li>○ Identify research questions</li> <li>○ Identify research methods</li> <li>○ Completion of action research template</li> </ul>
15.15 - 15.30	Next steps <ul style="list-style-type: none"> <li>○ Baseline e-survey deadline end April</li> <li>○ Working with researchers and SLC</li> </ul>

## Appendix 6 Self-Evaluation Questionnaire

All responses had three choices: 'often', 'sometimes' or 'rarely'.

### INSTRUCTIONS: Self-evaluation Checklist

Use this checklist to identify the practices within your classroom, department and school. Click where indicated to select your response regarding how regularly each of the practices occur in your school.

*This process may assist you to choose where you would like to focus the interventions for your action research. The headings correspond to the six 'clusters' of activity that have been identified as crucial in previous research. Which of these clusters*

Science Learning Centre Region:

School Name:

Teacher Name:

**Physics learned (and taught) in a way that is accessible and engaging for girls**

(please click to select ↓)

I use gender-neutral illustrations and examples

I use non-technical language and analogies where possible/appropriate

I provide context through linking topics and highlighting applications and social relevance

I use a variety of questioning techniques and build in thinking time and discussion into activities

(please click to select ↓)

**Progression routes visible**

I am aware of my students' ability and confidence levels in physics

Information advice & guidance (IAG) provided reflects the range of routes into physics post-16

(please click to select ↓)

**Relevant careers promoted**

Careers that interest students have been identified and promoted

I make links to careers within class

(please click to select ↓)

**Ethos of 'physics is for everyone': positive perception of the subject in school**

We have a positive school culture (identified e.g. through Ofsted)

There is support for physics at senior level in school, e.g. flexibility with timetable

Staff and students are proactive in discussing physics options

(please click to select ↓)

**Workforce: Girls [and boys] access good physics teaching**

Physics staff are supported in development

Specialist teaching is accessed pre- and post-16 to give continuity

Our workforce is effectively deployed to teach physics

(please click to select ↓)

**Classroom managed to promote girls' engagement in group work**

I assign roles for practical work to promote engagement

I differentiate between social and learning groups

I group students for teaching and learning, not classroom control

## Appendix 7 Action Research Plan Template

This template is designed to help you plan your action research project.

Your name .....

School .....

SLC region .....

Workshop date .....

### Section 1: The action

This section is about the change you're planning to make in your classroom, department or school

<p><b>Action research cluster</b></p> <p><i>Which of the six practice areas will your project address?</i></p> <ul style="list-style-type: none"> <li>• <i>Careers and guidance</i></li> <li>• <i>Progression routes</i></li> <li>• <i>Ethos</i></li> <li>• <i>Learning and teaching</i></li> <li>• <i>Classroom management</i></li> <li>• <i>Workforce</i></li> </ul>	
<p><b>Intervention</b></p> <p><i>What 'action' will you take as part of the action research project, i.e. what will change in your classroom or school?</i></p>	
<p><b>Expected outcome</b></p> <p><i>How will you know whether the intervention had an impact?</i></p> <p><i>What do you expect to change or look different in your classroom, department or school as a result of the intervention?</i></p>	

**Section 2: The research**

This section is about the ways in which you will measure the impact of the change you made.

<p><b>Research question(s)</b> <i>What broad question/s will you use to guide your research?</i></p>	
<p><b>Baseline information</b> <i>What information is available to you to help measure the effect of the intervention?</i></p>	
<p><b>Research methodology</b> <i>What research methods will you use to answer your research question/s?</i></p>	

**Section 3: Sharing your findings**

This section is about how you will share the findings of your action research project.

<p><b>Sharing findings</b></p> <p><i>Who might be interested in hearing about the findings of your research project? How will you share the findings of your research with colleagues and others?</i></p>	
<p><b>Additional notes and comments</b></p>	

## **Appendix 8**

### **Workshop 2 Suggested Schedule**

**Centres will adjust timings to suit their group. Suggested ways of recording the reflections on the day include Diary Room, web cam, photos, digital voice recorders... Online computer access will be needed for teachers to upload their project reports / self-evaluation questionnaire onto the community area of the portal. ACTION: All SLC project managers to ensure that a list of login details (including passwords) for everyone involved in their region is prepared in advance.**

See separate document for information to be sent directly to teachers.

#### **Aims of Workshop**

- Build teacher confidence & appreciation regarding their involvement (emphasise to teachers involved that what they have really useful and positive for the group)
- To stimulate further work, both in terms of teaching and action research
- Identify outcomes for the action research project and reflect upon them

#### **Indicative Schedule [responsibilities indicated in brackets]**

##### **Session 1: Setting the scene (30 mins) [joint]**

- Overview of project by SLC Project Managers (the Girls into Physics work past, present, future) CPD including TLA Stage 1 and where CPD is going.
- Update by External Research Team (literature review, teachers guide, Theory of Change, research clusters, action research)

##### **Session 2: Informal sharing of practice (up to 90 mins) [SLCs]**

- Opportunity for teachers to share the findings from their projects and hear about the successes and challenges that other teachers faced.
- 'Informal Feedback Template' (in hardcopy) to be used by teachers to note critical details and provide feedback to one another.

##### **Session 3a: Reflection and Reporting (up to 60 mins) [Eval team]**

- Teachers will work in pairs or small groups to edit their reporting templates (drafted in advance of the workshop) and provide feedback on each others' reports.

#### **LUNCH**

##### **Session 3b: Top Tips (30 mins) [SLCs]**

- Fast and furious session to capture teachers' key learning points from Session 2.
- Top tips to be collected on post it notes or similar.

### **Session 3c: Messages & Case Studies (up to 90 mins & break) [joint]**

- Session to identify key learning that should be disseminated more widely to other teachers. What are the key messages that other teachers need to know about? What would the individual teachers find useful to be told in order to help improve their own practice?
  - Case Studies will be produced (building on the reporting templates drafted previously) which are specifically aimed at teachers. Emphasis should be on the personal voice, story, narrative. Would be good to provide EXAMPLES of appropriate case studies (anyone got one available??) + an outline of how to develop a case study (Paul??). Peer feedback on case studies provided at end OR group is split into pairs etc. throughout - to be determined dependent on group size etc. [eval team]
  - Speed Dating session where each participant identifies two aspects and shares with other participants: 1 thing that they've learnt (from either their own or someone else's GiP project) and 1 thing they plan to do in future. [SLCs]
  - Self-evaluation template needs to be completed by each teacher - SLCs to provide online access and External Research Team to provide a hardcopy version as a back up. [eval team]

Groups that finish early may be encouraged to review the TLA Level 1 requirements?

### **Session 4: Next steps (30 mins) [SLCs]**

- Further Girls into Physics action research work
- CPD (incl. TLA)
- Certificates

### **Outputs from Teachers**

- Reporting templates not collected on the day to be sent to the External Research Team
- Case studies if teachers want to do this to be sent to External Research Team (then copied to Andrea for ASE)
- Select case studies / invite 2 teachers to ASE

***Absolute Deadline of 30<sup>th</sup> October***

## Appendix 9

### Workshop 2 Teacher Instructions

#### Pre-Workshop preparation

*Prior to the workshop please complete the following tasks:*

1. Fill in a draft version of the 'GiP Reporting Template' and upload it to your region's area of the Science Learning Centre web portal, clearly labelling your template with your school name.
2. Prepare a 5-minute update on the outcomes of your project so far. Bring as much evidence (pictures, reports, worksheets etc) that you think will be helpful to describe the experience and learning from the project. You could use the questions below to help you think what you will say:
  - What did I do?
  - What have I found out?
  - What do I want to do next?
  - What do I want to tell other teachers / IOP/ DCSF / SLC?

Make sure you also look out for the notice about TLA Stage 1 on the portal. This may be something you want to progress with based on the experience of this project.

#### Workshop Schedule

*The session will run from xxx to xxx and contain the following sessions:*

- Setting the Scene - overview and project update
- Informal sharing of practice - opportunity to share the findings from your project and hear about the successes and challenges that other teachers faced
- Reflection and reporting - discuss content, obtain feedback from peers and project staff and update your GiP Reporting Template
- Top Tips - capture of teachers' key learning points from the informal sharing of practice
- Messages & Case Studies - Identification of key learning that should be disseminated more widely to other teachers. What are the key messages that other teachers need to know about? What would you, as a teacher, find useful to be told in order to help improve your practice?
- Next Steps - identification of future personal direction with regards to Girls into Physics

## Appendix 10 Workshop 2 Reporting Template

This template is designed to help you report your results from your 'Girls into Physics' 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, clearly labelling your template with your school name. 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']*

<i>Careers and guidance</i>	
<i>Progression routes</i>	
<i>Ethos</i>	
<i>Learning and teaching</i>	
<i>Classroom management</i>	
<i>Workforce</i>	

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
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8. **Outcomes:** *What was the impact of your intervention? What evidence do you have for the stated impact? What has changed or is changing in your classroom, department or school as a result of the intervention? Was there anything unexpected that occurred?*  
[6 - 10 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 'Girls into Physics' project 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 11

### Teacher e-survey

All schools were asked to complete an e-survey to gather information on the broad characteristics of schools involved in the project including information relevant to widening participation in Higher Education, attainment and progression in physics and the background of teachers involved in the project. From the 33 responses to the e-survey submitted a qualitative profile of participating schools and supporting activities was drawn up relating to three elements of the survey, about participating schools, about physics teaching in participating schools, about the teachers teaching physics in participating schools.

*33 teachers completed the e-survey; this section presents the main findings.*

### Section 1: About schools

#### **Q2 Is the Girls into Physics project part of your school development plan? If so, what is the objective?**

For most of the schools the Girls into Physics project is not part of the School Development Plan (22 responses) with only 1 school stating that it is an objective. However several teachers (11 responses) commented on other plans which support the objectives of the Girls into Physics project. These include:

#### ***School level plans:***

Science School Development Plans (3): one school mentioned that girls into A Level Physics had been a specific objective in the School Development Plan previously; Science Status Targets (1) and specific objectives in the School Development Plan (3) of *“improving Post-16 uptake / attainment.”*

#### ***Department level plans:(5 responses)***

Some plans were focussed on pro-active and targeted recruitment to their subjects at sixth form including specifically to science and some had specific objectives to inspire interest in physics from both boys and girls. For some the Girls into Physics project will contribute specific resources for departments such as a scheme of work.

*“I hope to incorporate it into the development of the new KS3 SOW based on the new curriculum”.*

#### ***Personal development plans (3 responses)***

Responses showed how teachers were thinking about this at a practical and strategic level.

*“I am trying to improve my personal teaching of physics, with the aim of increasing the uptake of physics post-16. If the project is a success I aim to filter down my findings to other members of my faculty”*

*“I only became involved when this course got me thinking about our uptake, or lack of it!”*

### **Q3 Can you provide any information from OFSTED reports or other school documents which highlight your work on encouraging more girls to take up physics post-16?**

Similarly the Girls into Physics project or work on encouraging more girls to take up physics post-16 was not specifically mentioned in OFSTED reports (20 responses) but this work is highlighted in other important ways.

Faculty Reviews (2 responses) are considered an important mechanism to support the development of physics teaching.

*“From a faculty review it has been highlighted that the department are providing different pathways in science at post 16, allowing more students to take science beyond GCSE. Although this isn’t just Physics, it does promote science within the college. Specialist teachers are teaching physics at GCSE wherever the timetable allows. The department management allows and promotes training to be carried out by all staff to promote physics teaching at GCSE.”*

Specific interventions including those linked to ideas and concepts of good practice in Girls into physics project are highlighted (5 responses). These include interventions relating to careers information, advice and guidance such as: specialist lectures twice a year with individual follow up and active encouragement for girls to take physics (*“Numbers have crept up from 10% - 20%”*); Science, engineering and technology work experience placements targeted at girls; and specific requests from girls themselves who have *“requested outside professionals to come into school and to talk to them about their careers.”*

For some schools (3 responses) prioritising the encouragement of more girls to take up physics post-16 is part of a team or individual focus in their work demonstrated by involvement in this phase of Girls into Physics, previous teacher led research or as a team objective.

### **Q4 Is your school involved in any other aspiration raising activities such as Aimhigher, STEM, Stimulating Physics projects and so on?**

25 of the schools are involved in a number of aspiration raising activities. There is a strong link with Aimhigher among participating schools (22 responses). Some activity is more generic and focussed on aspiration to higher education and making explicit progression routes. Some of the activities focus specifically on science and physics as relevant for all and especially highlight the value of physics to careers.

*“[We are] involved in Aimhigher - involving trips to University of Southampton for Physics Days and Chemistry Days. Students involved in various projects and visit the Laser research team. At KS4 some students spend 3-4 days at the National Oceanography Centre in Southampton and work with staff there collecting and analysing data and interviewing staff about the science they use and their specific qualifications as part of their GCSE Applied Science - Science in the Workplace Assignment.”*

STEM projects (5 responses) contribute to the promotion of science as a valuable part of both the curriculum and extra-curriculum and feature after-schools clubs, awards, girl focussed and young person led activities.

*“Year 8 are doing the STEM leadership development course. A pilot is being run with 20 girls this year. They are being supervised by the Head of Year and hold most of the responsibility for accruing evidence themselves.”*

Other aspiration raising activities include Stimulating Physics (3), Engineering in Education (2), Physics Olympiad (2), Building Schools for the Future (1), Encouraging Pupils in Science KS4 (1), University linkages (1) and previously the Institute of Physics Paperclip Physics (1).

#### **Q5 Do your students have access to enrichment activities with a specific physics dimension?**

6 schools do not offer physics related enrichment activities but some have plans for future developments

*"We study Triple science on the 21st Century Scheme but unfortunately we are only timetabled for three one hour periods in a two week cycle which seriously cuts down even the enrichment activities we can offer during the main course. We are a Science specialist college so we hope to develop a junior science club and also science leaders to link with primary feeder schools."*

However, 19 schools do organise enrichment activities such as science, engineering, physics and astronomy clubs and take up opportunities throughout the year as appropriate (including National Science Week) and with external organisations such as universities and local industries. 19 schools have Science Clubs with most of these (12) focussed on Key Stage 3 and some schools (6) with additional clubs focussing on KS4. Other activities include competitions, links with WISE, links with Universities. One school offers the innovative combination of,

*"Science lessons for parents [and a] Science and Engineering Club."*

#### **Q6 About progression to Higher Education**

The steering group realise that information regarding numbers and destination of progression to HE may not be readily available to teachers participating in the project and some of the information may be anecdotal. 20 schools responded to this set of questions with 7-10 responses of 'not known' to different sections of the overall question. The section regarding further comments on progression to physics post-16 or higher education provides interesting qualitative data.

Of those who responded (12) with the % of students from your school progressing to HE in 2007, 5 schools were below 50% progression to HE (2% - 40%) and 6 schools were above 50 % progression to HE (52%- 95%). One school could give progression data to FE at 64.3%. The 'benchmark' for low participation in HE used by Aimhigher / HEFCE projects is 50% participation rate.

Of those who responded (11) with the number of students progressing to a HE course where physics is a requirement the number of students ranged from 2 to 11. Of those who responded (9) with the number of students progressing to a HE course where physics is not a requirement, but an advantage, the number of students ranged from 1 to 25.

11 Schools offered a range of comments on physics post-16 progression and progression to HE. 4 schools reported that they have a steadily increasing application rate to physics post-16 and HE and feel positive about the future. For some there are opportunities for strategic planning and workforce development.

*"With the new syllabus coming on line in September, the faculty are taking this chance to think of different strategies and interventions to promote physics at all key stages."*

Difficulties for progression are identified as: students are unsure about the difference between Physics, Biology and Chemistry for post-16 study; applied science not accepted as a science subject at a local college; and that physics is perceived to be, and experienced as, too hard at AS level.

For some schools while progression to HE is good or improving, very few are progressing to Physics related courses at HE and perhaps do not see it as a relevant subject.

*“Very few are intending to do Physics, most use their skills in maths and sciences to follow engineering based routes.”*

## **Section 2: About physics teaching in schools**

### **Q8 and Q9 Science curricula offered and timetable allocation at KS3 and KS4.**

Science Curricula offered at KS3 is mostly the national curriculum KS3 Curriculum. Specific curricula include Exploring Science, QCA scheme of work, OCR 21<sup>st</sup> Century Science, Triple Science, Hodder Science, Spotlight Science. One school offers its' own School Science curriculum combining Physics and Chemistry and one school offers Year 9 BTEC Science (EdExcel). The time allocation for the Science curriculum within the KS3 timetable ranged between 7% and 25%.

Science Curricula offered at KS4 includes OCR 21<sup>st</sup> Century Science, Electronics, EdExcel 360 Science, AQA Science, Gateway, BTEC Science (EdExcel) Year 9 and 10, Applied Science, Additional Science, Single Science, Science Double Award and Science Triple Award.

Allocation for Science curriculum of the KS4 timetable ranges from 7.5% to 25%.

Q10 Comments on the organisation of the curriculum in schools with particular relevance to physics.

The delivery of physics teaching within the curriculum was organised in different ways amongst the participating schools. Some schools (7) included identifiable separate Science subjects throughout, using distinguishable topics and / or teachers for the different sciences. More schools (10) organised KS3 as general science, with separate subjects and specialist teachers at KS4. Three schools organised science teaching into ability sets at KS3. Six schools ensure specialist physics teachers teach at Year 11 and 12, with two schools using specialist physics teachers from Year 9.

## **Section 3: About teachers of physics in schools**

### **Q11 and Q12 About qualifications**

Teachers physics qualifications range from PhD (2), MSc including MPhys and MEng (8) Physics BSc (25) BEd Physics (3) PGCE (4). 4 teachers had physics qualifications gained through inset and CPD for the teaching of physics. 3 teachers have A' level physics and 1 A' level chemistry. 3 teachers have GCSE double science award.

### **Q13 About additional experience (e.g. industry or careers) of teachers**

18 schools responded with information about teachers' range of additional experiences that may be relevant to science and physics teaching. This includes Engineering and Industry including design and build, research and development (12), Medical / NHS including science technician and health professional (5), Scientific research including academic research posts and PhD research (7), Careers (1) Other including youth work (3).

## Appendix 12

### Report on DCSF Girls into Physics data

An analysis of the data on all schools in England provided by DCSF has been conducted.

The charts in this Appendix compare demographics of four data sets:

1. **GiP final:** schools that completed the action research projects
2. **GiP initial:** schools that attended the first workshop but did not submit a report
3. **SLC regions:** regional averages for the SLC regions that participated in the project (excluding the National Science Learning Centre)
4. **All schools:** all secondary schools in England

#### Data sets

Of the 101 schools on the list of participating schools, six were not present on the DCSF data set. **Ninety-five schools** are included in the initial GiP schools sample (apart from the Level 3 data sets). Sixty schools completed the project. Of these, **fifty-five** are included in the final GiP schools sample.

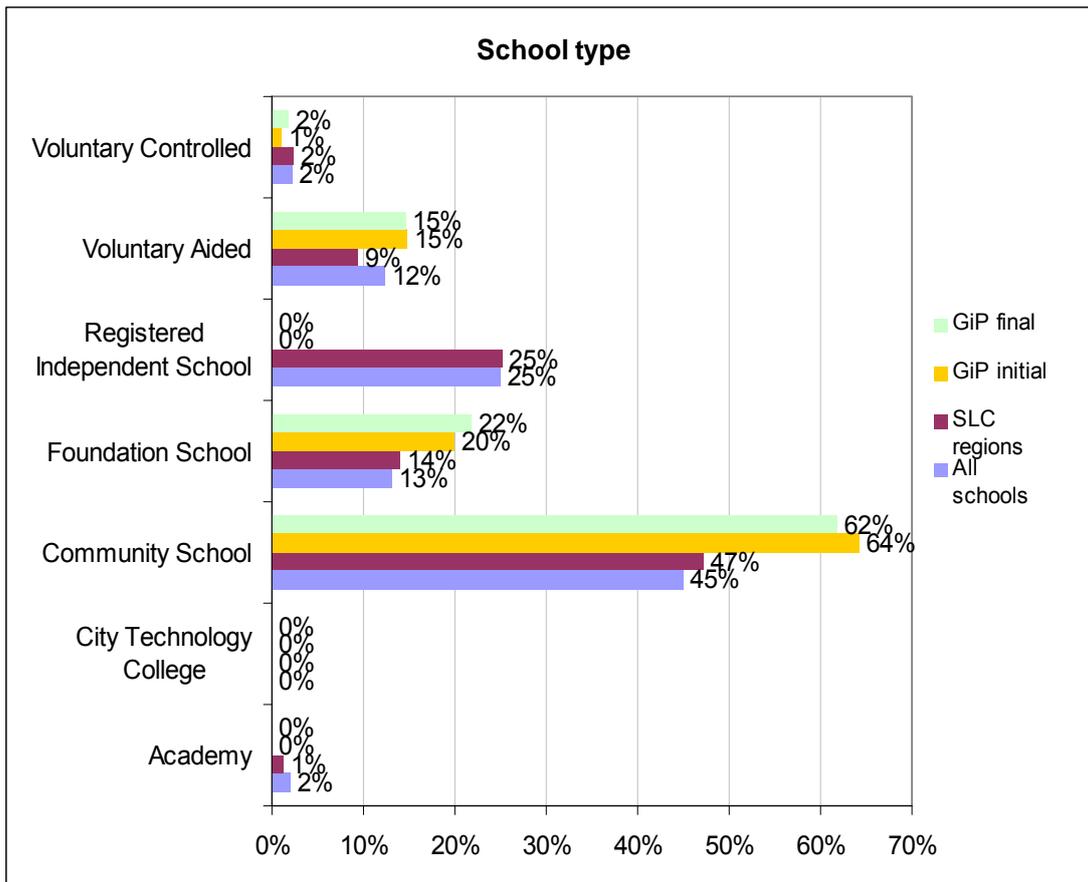
A further 33 schools were not present on the Level 3 database, indicating they do not have a sixth form (or are absent for another reason). **Sixty-three schools** are included in the Level 3 analysis for the initial GiP sample, and **thirty-seven** are included in the final project sample.

The national averages are provided by DCSF taken from the **>4000 schools** included in the secondary schools' database for attainment data and the 3383 non-independent secondary schools included in the data set for the demographic and FSM data.

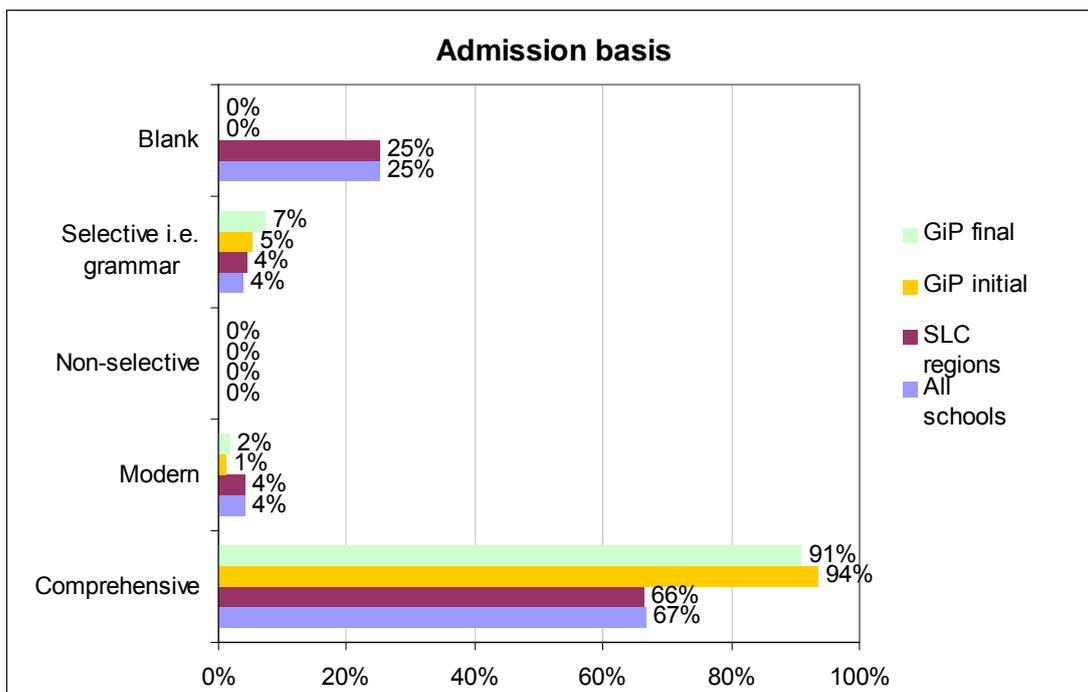
Depending on the data set, **2100-2400** schools were included in the regional sample. This sample included secondary schools in the participating SLC regions. This sample is a more realistic comparator for the project schools.

#### School types

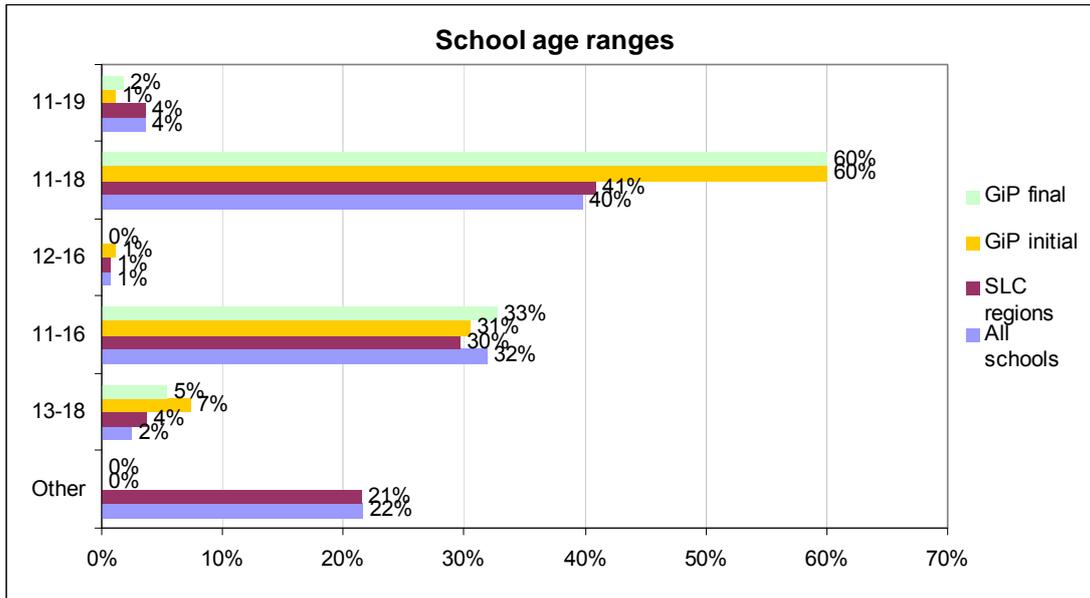
Schools are categorised in various ways. The following graphs compare the types of schools involved in the project with the national picture for England.



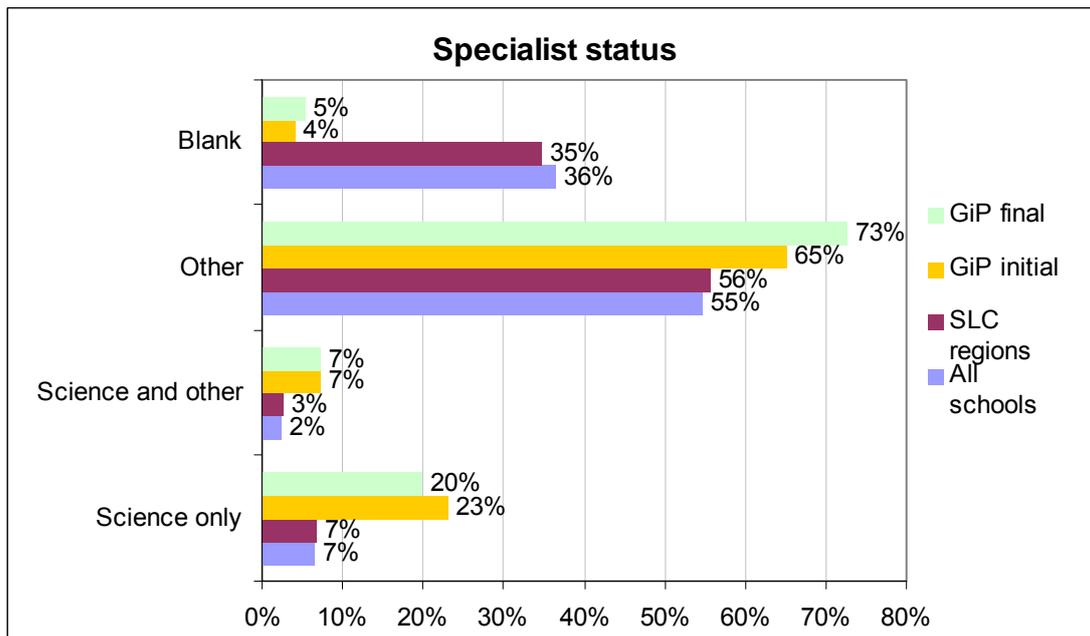
In the Girls into Physics samples, Community Schools are overrepresented and Independent Schools are underrepresented. This is not surprising given that funding for participation was only available to state-funded schools.



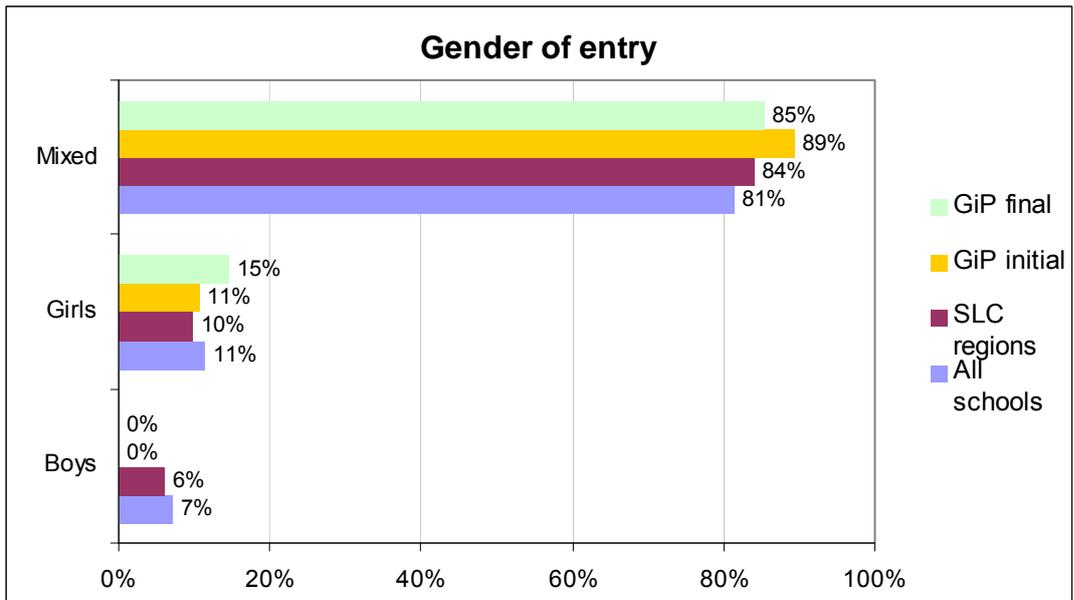
It appears that Comprehensive schools are overrepresented in the project samples; however there are large proportions of blank responses in the national and regional data sets.



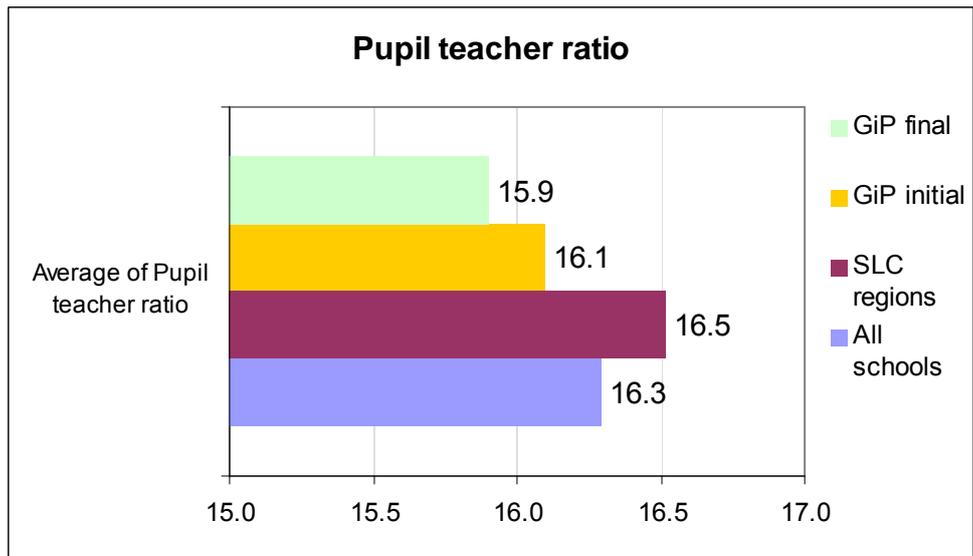
There are higher proportions of 11-18 schools in the project samples. The broader range of ages in the national sample may be related to the greater number of independent schools.



Specialist science colleges are over-represented in the project sample, which is unsurprising given its focus on physics. Interestingly, other specialist schools are also over-represented, especially in the sample of schools that completed the project. However there are significant proportions of 'blank' responses in the national and regional data sets; it is unclear whether these are schools with no specialism or schools that have not reported their specialism.

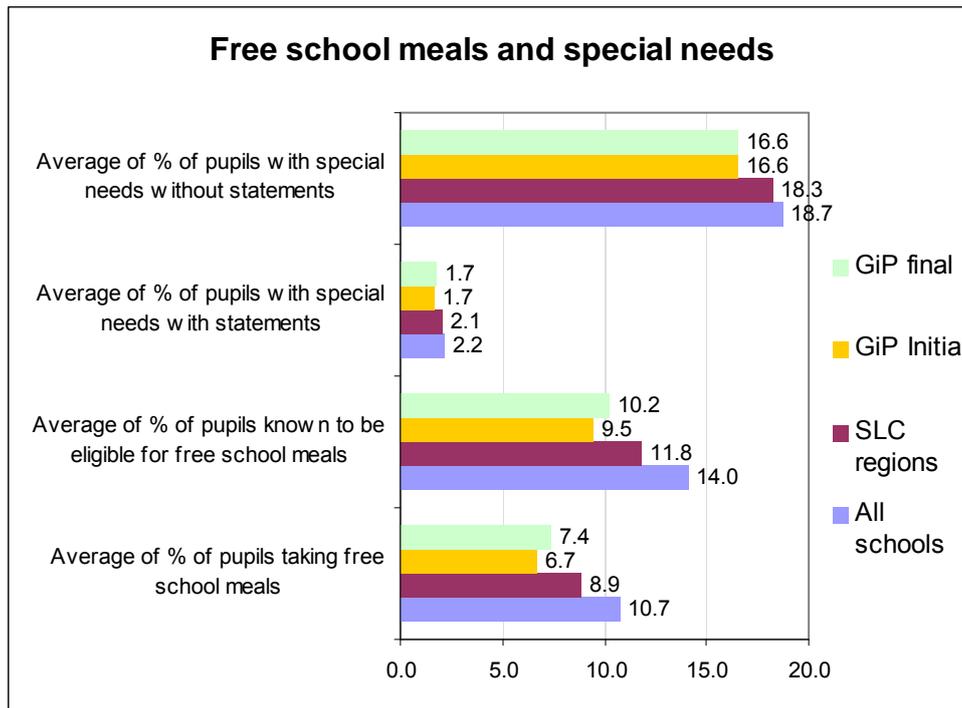


Unsurprisingly, no boys' schools are participating in the project. However it appears that on average the girls' schools that started the GiP project were more likely to complete it than the mixed schools.

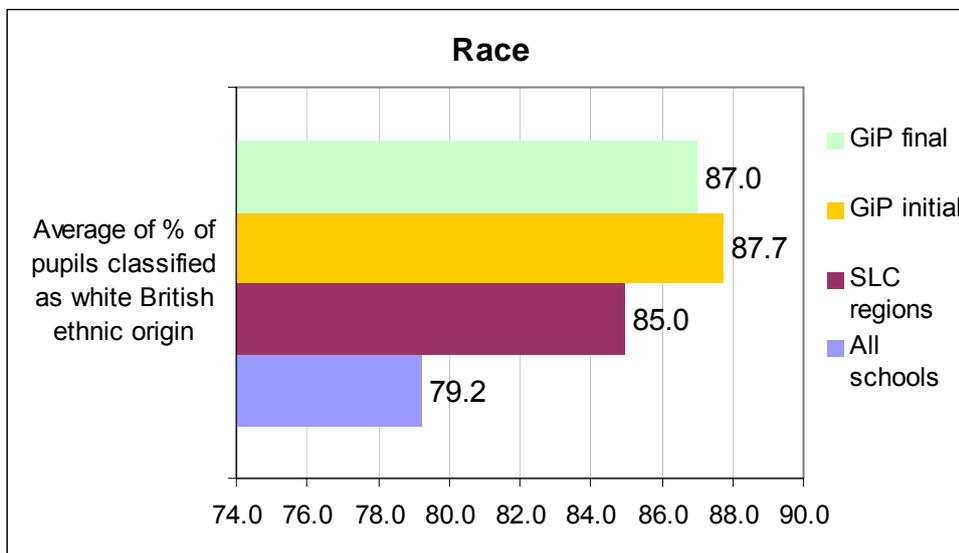


The ratio of pupils to teachers is slightly lower in project schools (especially those that completed the project) than the national and regional averages, although the differences are small.

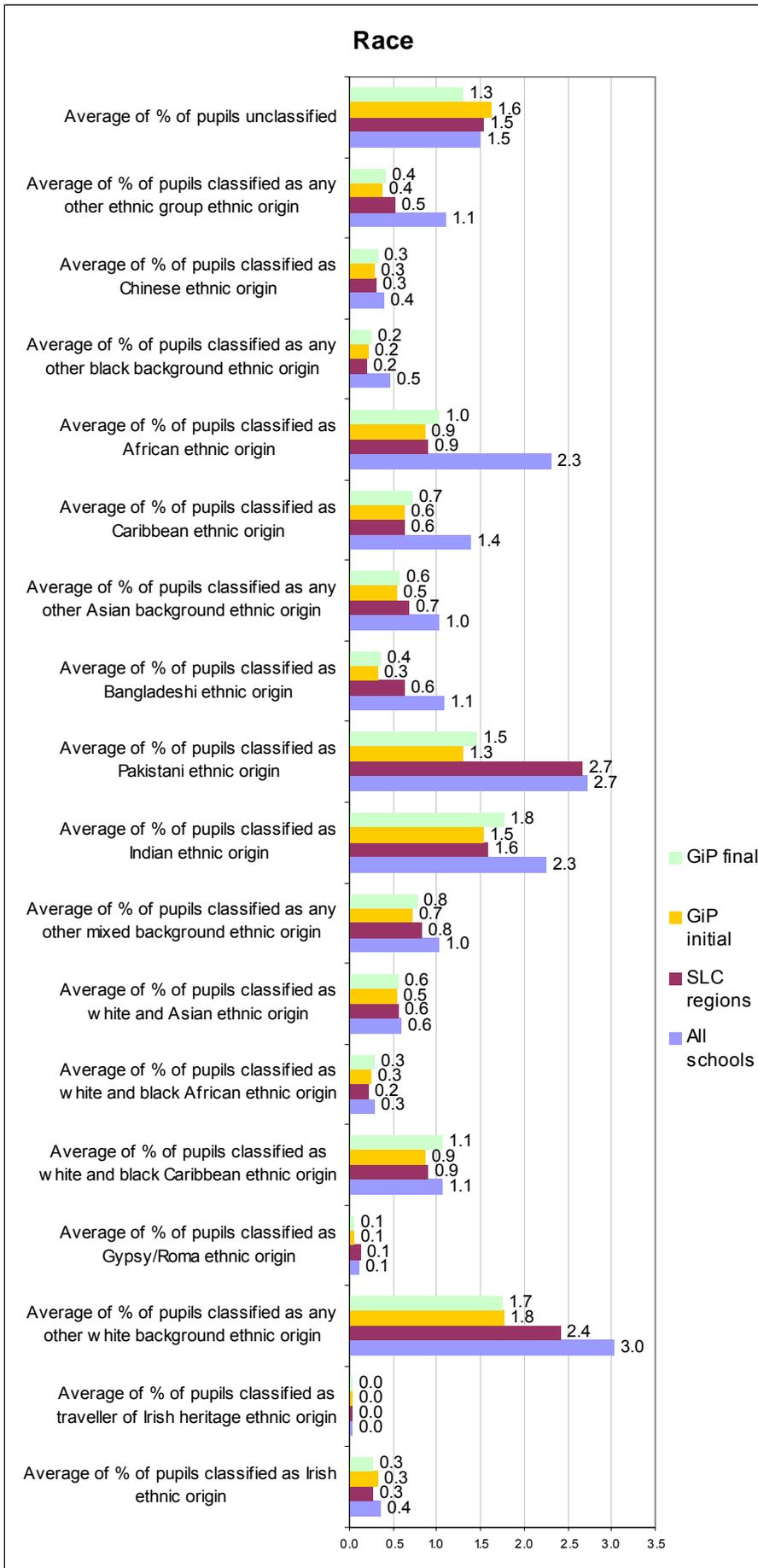
## Student demographics



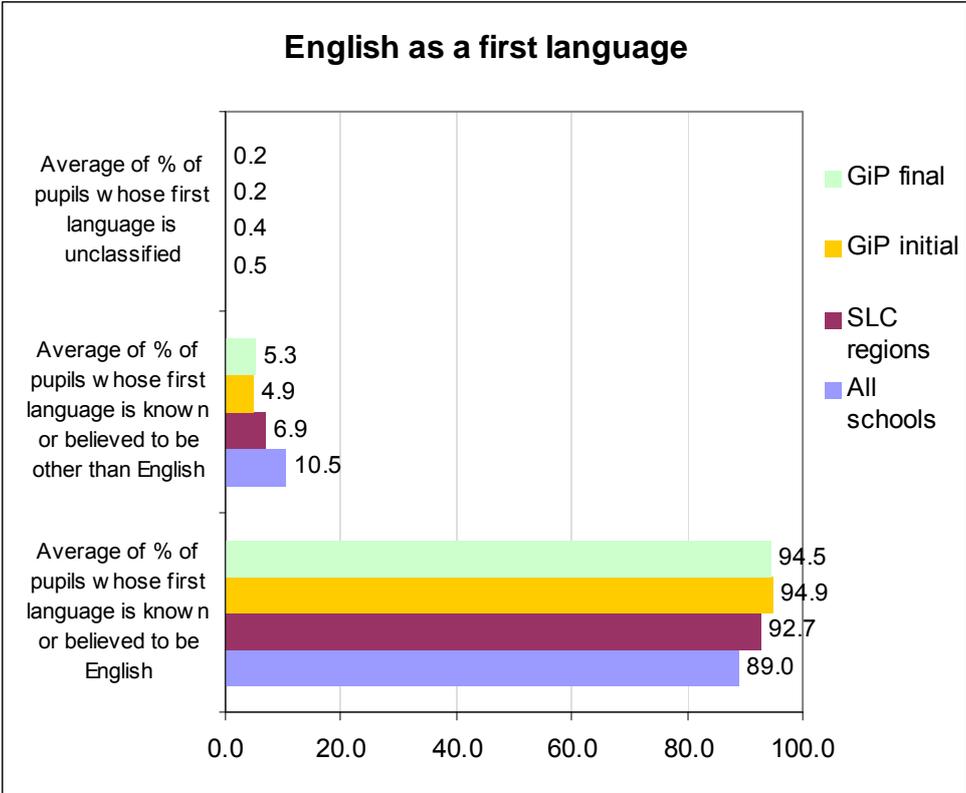
Project schools appear to have significantly smaller proportions of students that have special needs or that are eligible for free school meals (compared with national and regional averages). Interestingly, this difference is less marked for schools that completed the project.



White British students are over-represented in project schools compared to the regional and national picture, although the difference is less marked for schools that completed the project.

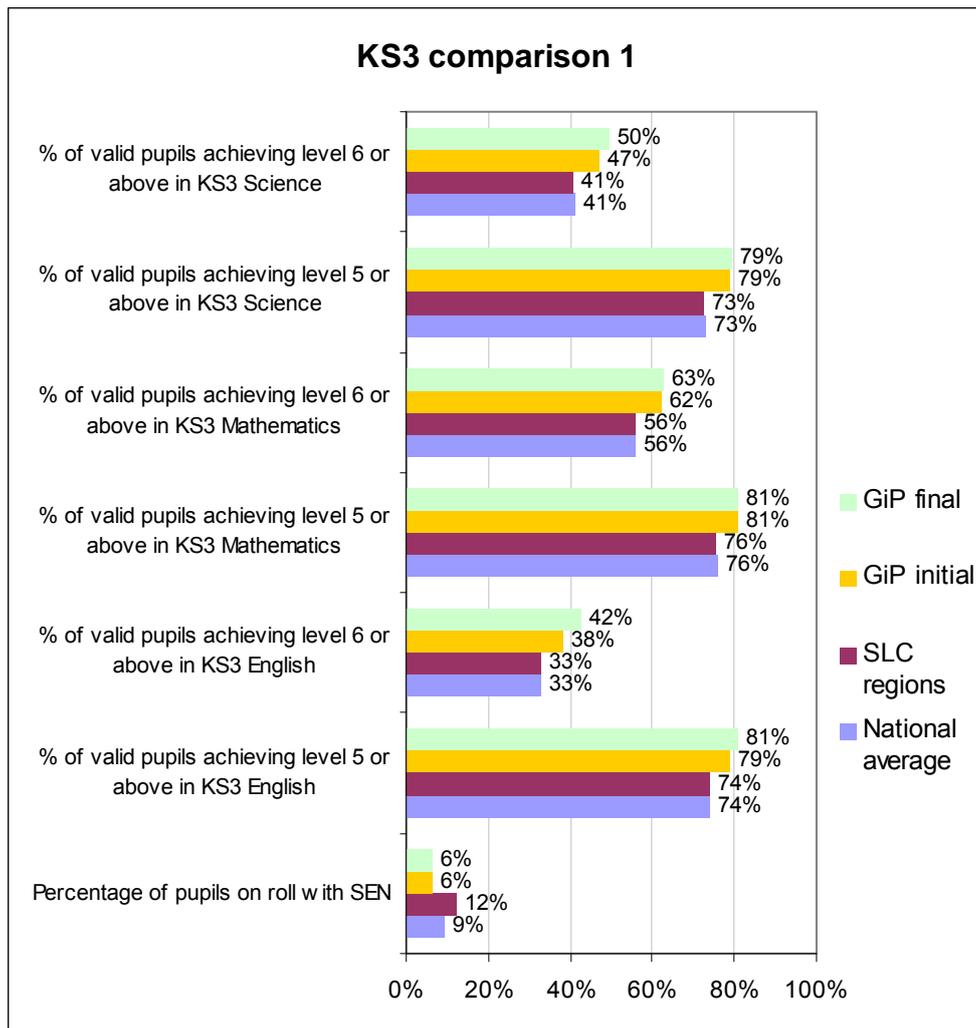


The national data set is the most diverse, as it includes the London region. Pakistani students are well represented in the SLC regions overall, but underrepresented in the project schools.

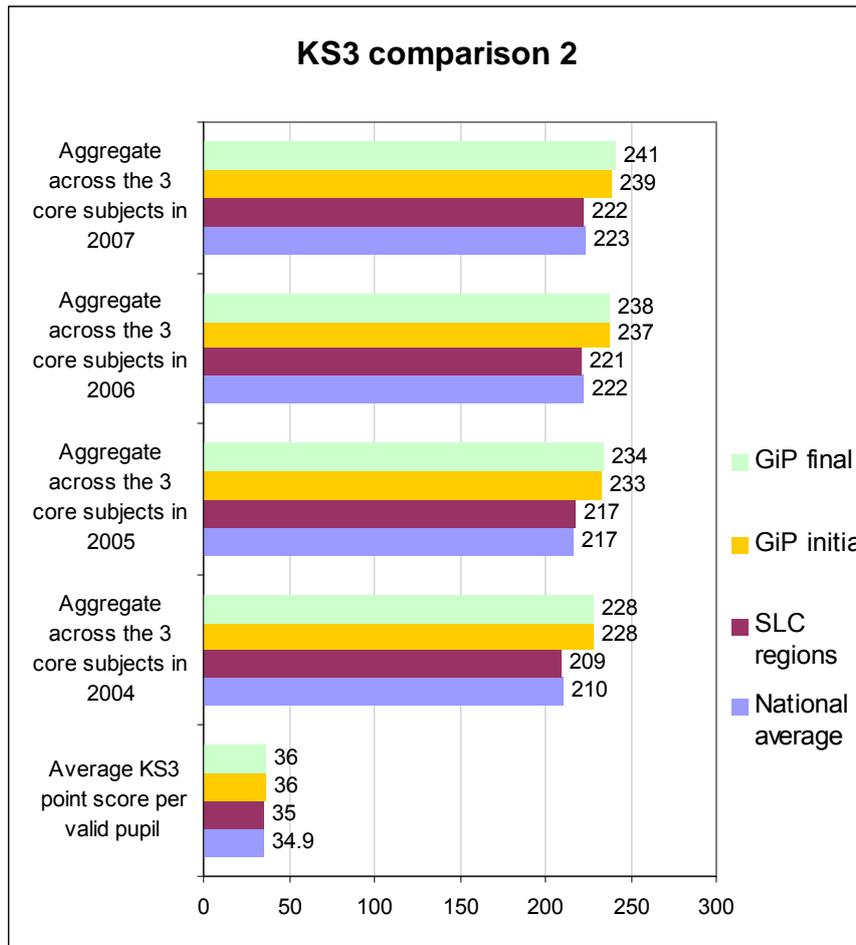


More students have English as their first language in project schools compared to the regional and national averages.

## KS3 data

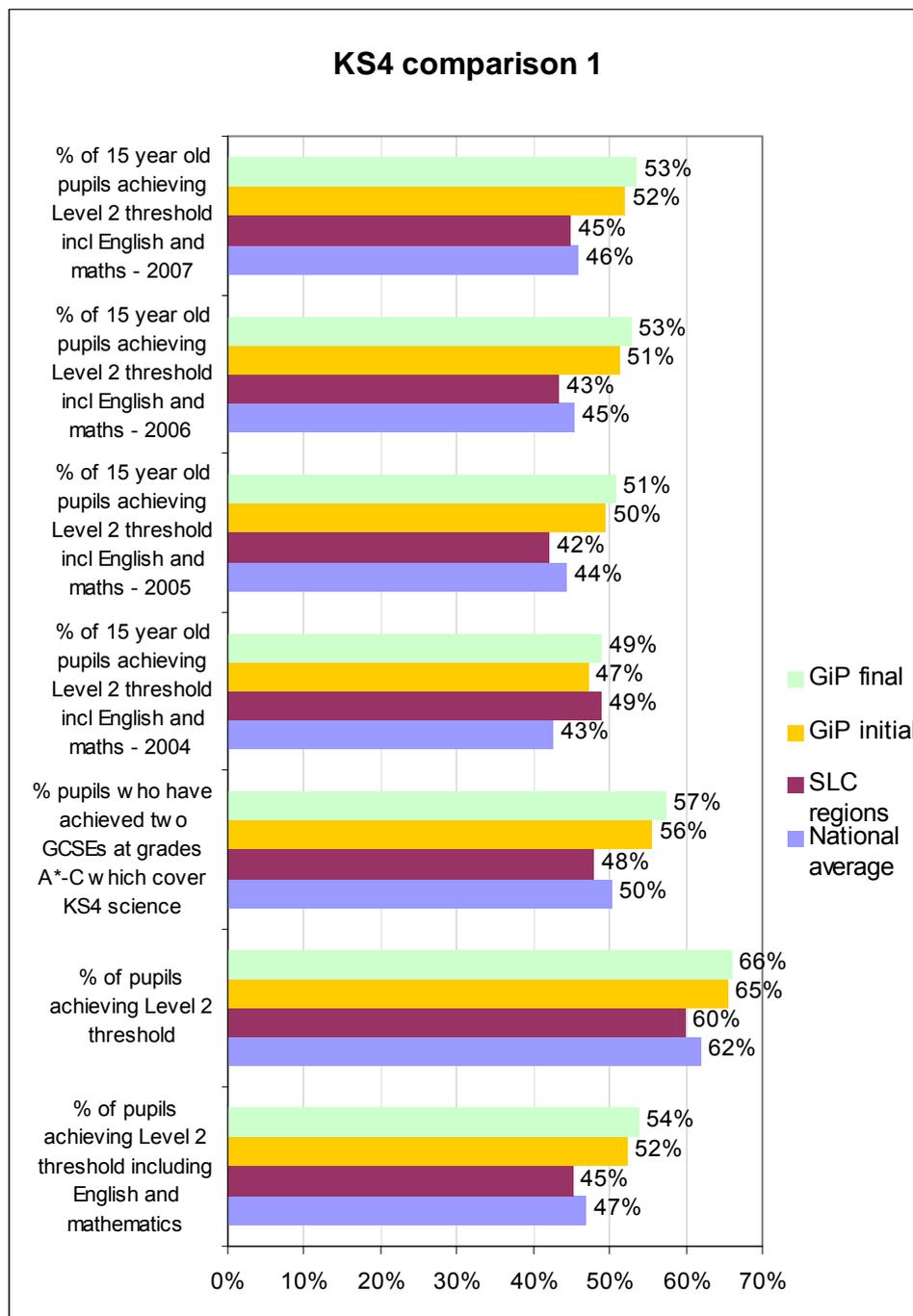


Schools participating in the action research projects consistently outperform the national and regional averages by 5 or 6 percentage points. Schools that completed the project were more likely to be those that performed better at KS3. They also have significantly fewer students with special educational needs compared to the national and regional picture.

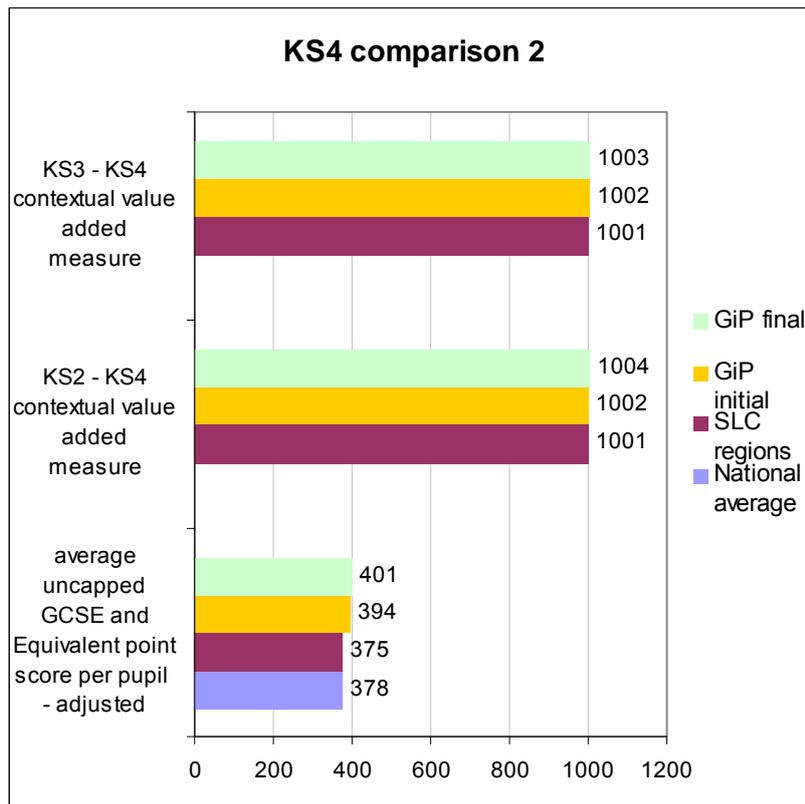


This graph shows aggregate KS3 scores from 2004-2007. On average, students at participating schools scored one point higher (or slightly more in the case of schools that completed the project) at KS3 than the national average and the average for the regions participating in the project.

## KS4 data

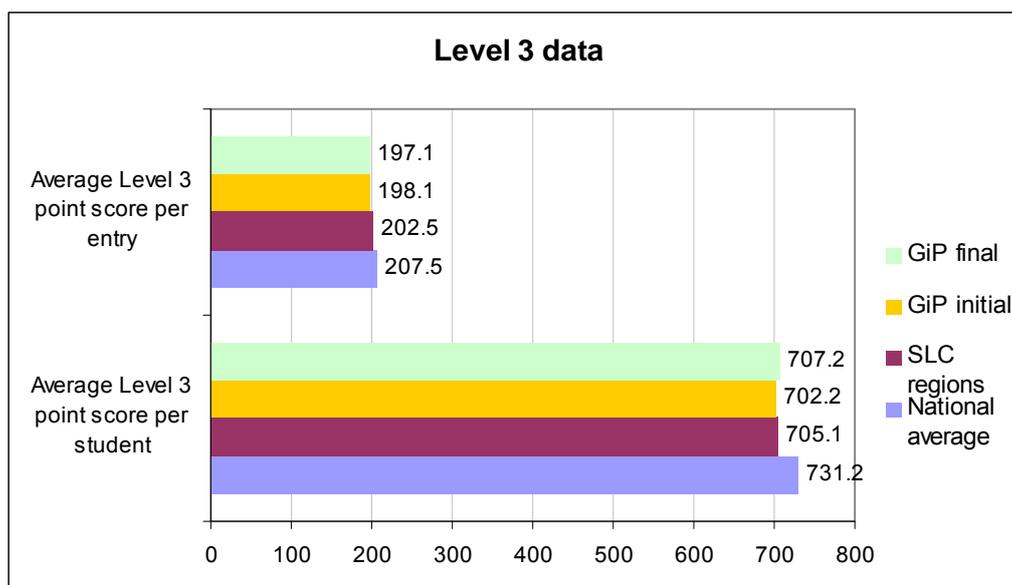


These data indicate that the GiP schools have consistently outperformed the national and regional averages at Level 2 (apart from in 2004). Compared to the averages for the participating regions, the improved performance is even more apparent. It also appears that schools with better attainment at KS4 were more likely to complete the project.



This chart indicates that while the project schools performed on average better at Level 2, in terms of the added value measures they are only slightly better than the average for the regions they represent.

### Level 3 data



Not all of the schools included in the data set have a sixth form. Of those that do, attainment levels are slightly lower than the national average, but the per student scores for schools that completed the project are slightly higher than the average for the SLC regions involved in the project.

## Appendix 13

### Full list of 'Top Tips' identified by teachers

*This Appendix contains a list of 'top tips' identified by the teachers involved in Girls into Physics Phase 2. The tips have been sorted by suggested themes and are written in the teachers' own words.*

#### Teaching & Learning:

- Ensure girls are valued in the classroom
- Deliver learning context lead
- Make Physics fun
- Use no hands up questioning
- Encourage TLS Discussion Debate Creative Presentation
- Investigate process learning styles and implement in the classroom
- Try to include the social aspects of physics
- Be aware of the barrier of language. Use games and communication strategies to get an input into the activities
- Make physics relevant to everyday life
- Give chances for discussion
- Make it relevant to everyday life
- Personalised learning based on knowledge of the range of students learning styles and additional skills.
- Independent learning using approaches to enable students to have choices in responses, contexts and approaches.
- Student peer-led learning based on students communication and facilitative skills
- Co-operative learning to enable students to support and learn from each other as well as see the teachers involved in a learning process with them.
- Build confidence -> Get the girls to answer on the board
- Build confidence in girls (small group work, explaining to rest of class, praise, reassurance...)
- Allocate specific roles to students during group work
- Allocate exciting names to the roles
- Make it relevant - to do with people
- Link to everyday experience
- link physics to everyday relevant experiences
- Blend the boundaries between the sciences
- Teach application first then content
- Make lesson relevant to everyday life
- Group discussion of understanding of concept/role play at the end of lessons. Groups report back/present role play.
- Girls take an active role in lessons.
- Group students so that enthusiastic students work with less motivated ones.
- Awareness of 'the big picture'.

## Careers:

- Use external speakers to enthuse students
- List of websites with pupil friendly info on careers where physics is useful
- Incorporate careers opportunities into each lesson
- Visits by real scientists
- Examples of people (young?) that have interesting jobs involving physics e.g. [www.noisemakers](http://www.noisemakers) with video clips - not like sample students in university prospectuses
- Learning about careers in lessons. We don't learn about it anywhere else.
- Careers info @ an early stage
- Careers info @ early stages
- Careers advice early - anything in KS3. Speaks, visits, case studies.
- Research different jobs that physicists do now
- Year 9 to have appropriate career guidance
- Display careers info at Post-16 info evenings
- Careers info in early years
- Good careers information, particularly in early years
- Raise profile of physics careers & Unit study (past students & visits)
- Marketing of A level early on in GCSE course
- Show relevance to people + careers - build links into schemes of work
- Careers early years
- Raise the profile of Physics careers
- Market A level early in GCSE
- Give careers advice young
- Try to increase awareness of careers opportunities
- It's a teacher's job to advise on careers because the careers dept don't know about science jobs
- Careers as starter focus linked to subject for rest of lesson
- Show how physics can be used in jobs

## Extra Curricula:

- Build links with other STEM subjects to increase relevance of physics
- Work with colleagues outside the classroom e.g. in clubs etc
- Science lessons for parents
- Using pupils to teach in primary school classes.
- Get outside agencies involved (key speakers, IOP, local hospital staff, people doing physics related jobs, other projects e.g. Researchers in Residence)
- Work with colleagues outside the classroom e.g. in clubs etc
- Share the ideas more broadly in clubs etc.

## **Role models - Teachers**

- DO NOT tell pupils "I'm not very good at physics"
- DO NOT tell pupils "physics is hard"
- DO tell pupils "Everyone can do physics"
- Be enthusiastic
- Know your subject
- Look at your own practice
- As much praise as possible for all
- At every opportunity try to raise aspirations
- Check & counter girls negative perceptions about abilities
- Encourage the destructive tendencies of girls
- Change perception of difficulty
- Change the perception that physics is hard
- Look at own teaching
- Make no assumptions
- Try to change perception of physics being hard
- Know your subject
- Shift perception of physics being hard -> evidence
- Change perception of physics being difficult
- Reflection of your own practice
- Be enthusiastic
- Value the informal and have fun!
- Change perception of physics being hard
- Be enthusiastic
- Be enthusiastic
- Teachers need to be enthusiastic!
- Be approachable!
- Give them confidence in their own ability
- Build confidence in the subject

## **Professional development:**

- Don't assume teachers are doing what you think?
- Demonstrate change "DVD" of teaching physics
- Monitor teaching performance
- Video to show other teachers
- Inform all science staff of the content of the physics course
- Work together with colleagues to develop ideas
- Sharing good practice
- Communication with students & staff

## **Resources:**

- Use songs and music videos on YouTube
- TOYS! at KS3 (to engage)
- Mini whiteboards
- Using IT modelling as a plenary to give girls 'a picture' of more abstract theories
- Use resources that are not gender biased.
- Make movies.
- Models etc to show understanding of topics.
- Girl friendly examples e.g. hair straighteners.

### **Action research:**

- It's always ongoing and more ideas will be created
- Give yourself lots of time to complete this. Maybe starting in September and having a year to do it.
- Focus groups with girls discussing issues related to IoP research.
- Identify a 'small' change in practice as the focus. The key is to make that small change significant.
- Time interventions accordingly
- Reflection on practice - make no assumptions
- Having the GIP project has been good motivation for trying new ideas and methods
- Keep your initial survey simple
- Get opinions straight away after the task
- Be prepared! Well planned.
- Think about the time of year. Will they be doing exams?
- Would be good to run the project over the course of a year.
- Use student researchers
- Having a research culture in the school leads to useful conversations between faculties
- It is difficult to decide impact of your research with so many other initiatives going on at once.
- Student researchers running the project make a big impact. Other students open up to them and take them seriously.
- Talk to your colleagues early on about what you are trying to do
- Get support from senior management
- Ask your students what they think
- Focus on an area you can take action on with your project.
- Ensure pupils know what is going on and feel ownership of the project.
- Involve students at all stages including the planning stages and rationale
- The project may engage students in physics as they may become motivated through being involved in the research
- Taking a risk is so much easier in a comfort zone. A non-specialist may be taking a bigger risk. So what is helpful about this project is getting support and it is rooted in sound practice which has been researched. Then when you go back to school you can get the support of senior management and feel more confident in your practice as a non-specialist.
- Do something small to try out ideas and see if students learn from them and adapt activity based on reflections.

### **Other**

- Use former / current older students to 'spread the word'
- Think carefully about staff teaching physics. Young? Specialist

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