



Girls into Physics: Action Research

A practical guide to developing and embedding good classroom practice

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1 Introduction

1.1 What's in this guide and who is it for?

This guide is a practical resource for teachers interested in understanding and removing the barriers to girls' progression in physics through a practice-based inquiry process described as action research. While action research might sound scary if you haven't heard of it before, essentially it's about making a change in your school or classroom and reflecting on whether or not what you did worked. Think of it as reflective practice with a little bit of extra reflection.

This guide is designed for teachers who may be trying out action research for the first time. However, we hope that it will also provide some useful tips even if you already have some experience of action research.

Participating teachers found some of the changes they made worked, some didn't. In this guide we have captured teachers' stories and tips to help you make a difference to girls' participation in physics, whether you work in a mixed or single-sex school. In fact it's not just limited to girls; some teachers reported that positive changes they made increased boys' engagement too.

1.2 Can this guide help you?

Can you answer "yes" to any of the following questions?

- I'd like to make physics more appealing to girls, but I don't know where to start.
- The girls in my class are attentive in lessons and do well in exams, but few choose to carry on with physics.
- I have tried to make physics more engaging to girls in my classes, but I don't know whether it is working.
- My students often ask "why are we doing this?" or "what's the point?"
- Other staff in my department are looking to me to make difference in this area.
- There is a long history of girls not participating in physics in my school, I'm not convinced there's much I can do about it.

- I'm frustrated that despite my best efforts, girls just don't seem to share my enthusiasm for physics.
- We've tried numerous approaches to increasing girls' participation over the years, but none seem to have had a long-term effect.

If the answer to any of these questions is "yes" then read on – the process of change starts here. In fact, action research methods can be used to stimulate and understand changes in many areas of education, not just girls' participation.

1.3 How to use this guide

The best approach is to read through the guide before you start, as it explains the whole process and what to expect. You can then use the toolkit provided in section 10 to plan, deliver and reflect on your project. There are also some FAQs to help out with common pitfalls with action research.

Section 1 is an introduction – which you've just finished reading.

Section 2 tells you a bit about action research.

Section 3 is designed to help you choose your intervention – the thing you're going to change in your classroom or school.

Section 4 will help you develop an action research plan.

Section 5 includes some troubleshooting tips for delivering your action research.

Section 6 describes approaches to evaluating the success of your project.

Section 7 is about sharing your findings with colleagues.

Section 10 includes the tools referred to within the guide.

Throughout the guide, teachers' tips and case studies are used to highlight ways in which action research helped them make a difference to girls' participation in physics.

1.4 The Girls into Physics: Action Research programme

This practical guide to action research draws on the experiences of 100 teachers across England who took steps to change the culture of girls' low participation in physics. The teachers took part in the Institute of Physics Girls into Physics: Action Research programme, which was aimed at supporting teachers to understand the issues relating to girls' participation in physics and to take action in their own classrooms, departments and schools.

The three elements of the Institute of Physics Girls into Physics: Action Research programme were:



The first two elements of the programme included the publication by the Institute of Physics of two helpful resources, which became known in the programme as the “Red Books”. They are:

- *Girls in the Physics Classroom: A Review of the Research on the Participation of Girls in Physics* (Murphy and Whitelegg, 2006)
- *Girls in the Physics Classroom: A Teachers guide for Action* (Hollins *et al.*, 2006)

These two publications are referred to throughout this guide and are highly recommended if you are interested in making a difference to girls' participation in physics.

The third element, the action research programme, was designed to help teachers who wanted to try

out some of the practices in the “guide to action” and judge whether they had made a difference. Initially piloted by the Science Learning Centres in 2006–2007, 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 with the aim of gauging the success of the interventions that schools undertook as part of the project.

The Institute of Physics has commissioned this publication to support more teachers to use a reflective inquiry process as a practical way to identify and remove barriers to girls' participation in physics.

2 Action research

2.1 What is action research?

Teachers who used this approach found the following definitions useful.

Action research is a flexible spiral process, which allows action (change, improvement) and research (understanding, knowledge) to be achieved at the same time. The understanding allows more informed change and at the same time is informed by that change. People affected by the change are usually involved in the action research. This allows the understanding to be widely shared and the change to be pursued with commitment.

(Dick, 2002)

I came to see action research not as a set of concrete steps but as a process of learning from experience. Working out ideas is the learning. A final outcome does not exist; we are always on the move.

(McNiff and Whitehead, 2002)

“Action” involves participants making or implementing change, rather than just investigating an issue.

“Research” involves participants in making informed decisions about what and how they are going to implement change. They fully research the current situation and potential changes before implementation. They also collect valid data to evaluate the changes they made.

(Adapted from Piggot-Irvine, 2002)

Any action research approach has three broad and cyclical steps of: plan; act and observe; and reflect and review (McNiff *et al.*, 1996; Bradbury and Reason, 2004). In this guide, two more steps have been added to the cycle based on the experiences of teachers involved in the project, which unpack the planning and reviewing steps in a little more detail. These five steps are outlined in section 2.3.

2.2 Why action research and not just action, or just research?

The Girls into Physics: Action Research programme indicated that teachers felt bombarded with ideas, guides and policies about how to get more girls interested in physics.

So where do you start? Teachers found that the key to a successful project was to start by understanding the context in your own classroom, department or school, and to identify a small change that you have the power to make and understand. Applying “good practice” in an unfocused way can be a waste of your time and energy, only you know what would work in your school with your own students. Action research is all about positioning you as the agent of change in the situation. So pick an area that you are interested in and can be enthusiastic about; it will make the whole process more worthwhile.

2.3 What does action research involve?

Expanding slightly on the three steps described on the left, this guide describes the action research process in five steps.

1. Decide on the intervention
(the thing you’re going to change)
2. Plan the action research
3. Do the action research
4. Reflect on success
5. Share learning



The next sections of the guide describe each step in greater detail.



3 | Step 1: Decide on intervention

What does educational research tell me?

What is the situation in my classroom and school?

What can I change?

3 Step 1: Decide on your intervention

To decide on your intervention, you will need to consider what the research says, what the situation is in your own classroom and school, and which aspects you have the power to change.

3.1 What does educational research tell me?

Factors affecting girls' attitudes

Educational researchers have collected a great deal of evidence about why girls are less likely to continue with physics than boys. In their review of the literature, Murphy and Whitelegg (2006) distilled this into three major factors that shape the way students feel about physics.

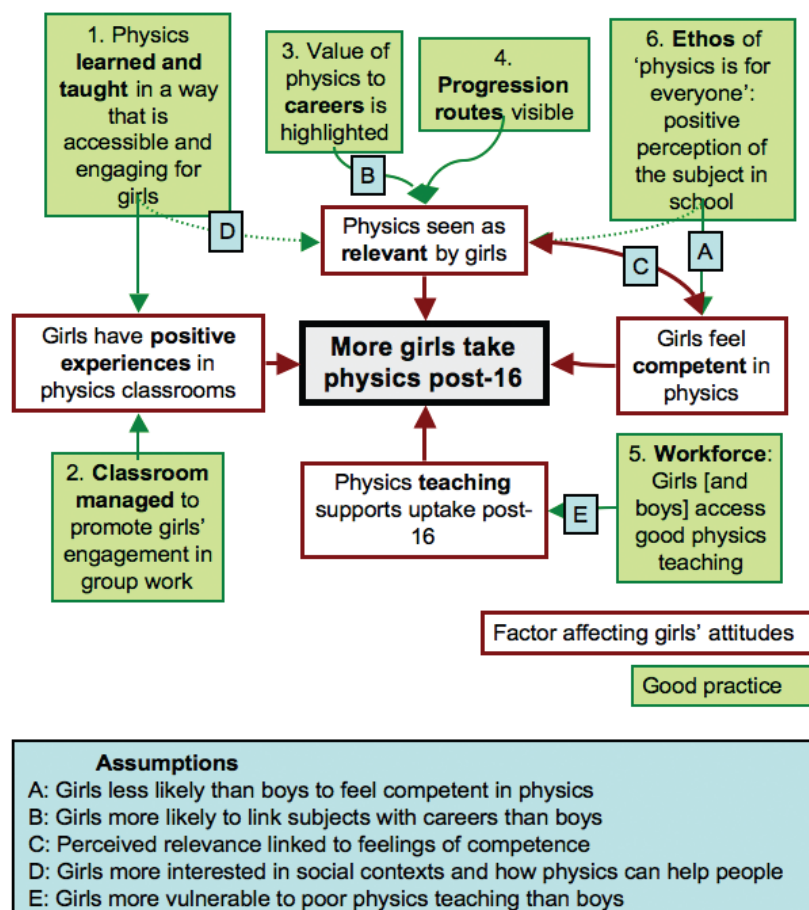
1. How they see themselves in relation to physics, including its perceived relevance and whether they feel competent in it (known as physics "self-concept").
2. Their experiences of physics at school.
3. A personally supportive physics teacher.

Good practice

Based on these factors, the Girls into Physics: Action Research work identified six areas of good practice that could improve attitudes.

1. Learning and teaching
2. Classroom management
3. Careers
4. Progression
5. Workforce
6. Culture and ethos

The factors that affect attitudes (red boxes) and the types of actions that could change them (green boxes) are represented in the Theory of Change diagram below.



Effective pedagogies

Each of the areas of good practice areas contained a cluster of several smaller actions or pedagogies. Choosing a single action or pedagogy is an ideal starting point for action research.

Some further detail on each area of good practice and the cluster of effective pedagogies within it is provided in the table below.

1. Physics learned (and taught) in a way that is accessible and engaging for girls 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. Effective pedagogies: • Gender-neutral illustrations and examples • Non-technical language and analogies used where possible/appropriate • Context provided by linking topics and highlighting applications and social relevance • Variety of questioning techniques used; build in thinking time and discussion	2. Classroom managed to promote girls' engagement in group work Interventions in this research cluster explore how classrooms can be managed to promote girls' involvement in group work. The assumption is that teachers will already be adopting learner-centred practices, so interventions will focus on additional practices that can be adopted to engage girls. Effective pedagogies: • Roles assigned for practical work to promote engagement • Differentiation between social and learning groups • Students grouped for teaching and learning, not classroom control
3. Relevant careers promoted This cluster focuses on interventions that 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. Effective pedagogies: • Careers that interest students have been identified and promoted • Links to careers made within class	4. Progression routes visible This cluster looks at how teachers and careers staff within schools can promote the range of routes into physics post-16. The assumption here is that by placing physics in the context of a progression route, girls will see its relevance to their educational and career goals. Effective pedagogies: • Teachers aware of students' ability and confidence levels in physics • Information, advice & guidance (IAG) provided reflects the range of routes into physics post-16
5. Workforce: girls (and boys) access good physics teaching 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. Effective pedagogies: • Physics staff are supported in development • Specialist teaching is accessed pre- and post-16 to give continuity • Workforce is effectively deployed to teach physics	6. Ethos of "physics is for everyone": positive perception of the subject in school 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, girls' physics self-concept (i.e. how they see physics as something relevant to them that they are good at) can be improved. Effective pedagogies: • 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

3 Step 1: Decide on your intervention

3.2 What is the situation in my classroom and school?

Once you have an understanding of the broader themes in the literature, the next stage is to understand the specific situation in your classroom and school. The girls in your classes may be experiencing different types of barriers, so understanding where these lie will help you target your intervention accordingly. Making links between the literature themes and your local context will help towards making a meaningful change in girls' participation.

There are four key sources of information that you can use to do this. You may wish to use more than one.

- Attainment and other data
- Self-evaluation
- Feedback from students
- Feedback from colleagues

Attainment and other data

The *Narrowing the Gap* report (DCSF, 2009) contains some tools for interrogating pupil and school-level data to explore differences in performance between boys and girls. Possible data sources are as follows.

- School-level data (including analysis) could include attainment at GCSE, AS and A-level for boys and girls, progression to sciences (including physics) post-16 and destinations.
- Local authority data to compare the picture across your area.
- RAISEonline www.RAISEonline.org, which provides an interactive analysis of school and pupil performance data.
- Fischer Family Trust Analyses to Support Self-Evaluation, to provide progress data for science including comparisons of low-, middle- and high-ability boys and girls
www.fischertrust.org/
- Specialist Schools and Academies Trust Data Enabler Toolkit (available from www.specialistschools.org.uk/).

Self-evaluation

With all of this information it can be difficult to know where to start, and can seem that there is an overwhelming amount to do. Several of the tools provided in section 10 can help you identify a starting point for change.

The self-evaluation checklist included in the toolkit that accompanies this guide (see section 10) was used by teachers in the Girls into Physics: Action Research programme and links to the six good practice areas discussed earlier in section 3.1. In addition, a number of other good practice checklists are available from the Institute of Physics and others, which may also be useful in reflecting on gender-aware physics teaching.

DO IT!

Use the self-evaluation checklist to reflect on your own/your department's/your school's practice.

DO IT!

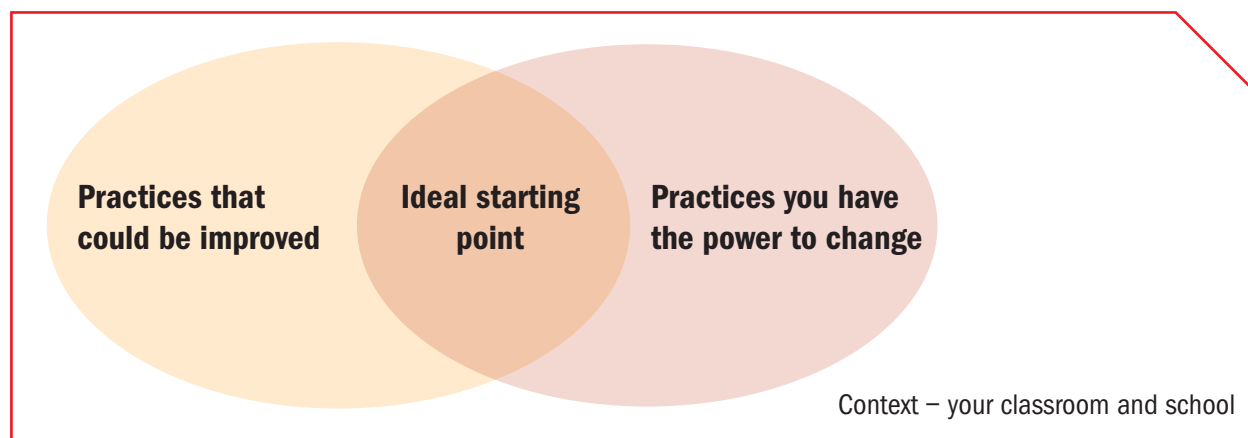
Use the Theory of Change to reflect on aspects of change and to identify effective pedagogies that you could try out.

DO IT!

Try out the DO IT! Diamond 9 ranking exercise to identify which interventions appeal to you.

All of the exercises listed above are included in the action research toolkit.

Now you have identified some interventions you could try out. To find an area where change is likely to work, think of these two factors within the context of your classroom and school:



The self-evaluation checklist will have helped you identify the practices that could be improved. But you also need to look at an area where you have the power to make a change. For example, if you've only recently started teaching you will have lots of control over what happens in your classroom, but perhaps less influence at departmental or school level. In contrast, if you're a member of the senior management team you might have less teaching time, but be in a position to make changes that relate to the workforce or school culture.

Most importantly, select an area of work that you're curious and enthusiastic about. This will make the process more rewarding.

Feedback from students

Another source of information about the reality of the current situation for your students is to ask them. Asking for feedback on your teaching directly from students can be a daunting yet rewarding task; teachers involved in the Girls into Physics: Action Research project certainly found it so.

"In my experience, asking for feedback feels a bit scary at the time, but is usually useful and more confidence boosting than not."

"It means having a trusting relationship with ones students and being open to some criticism. Incredibly positive and worthwhile experience."

"It was difficult to bring yourself to do it, concerns about negative feedback. But they felt good about being asked and I felt good about the positive feedback and the negative feedback (once I had acted on it). I have done it since."

There are several approaches you might use. Teachers who took part in the Girls into Physics: Action Research programme found that qualitative information was often more useful than quantitative information here – while questionnaires with lots of tick boxes were easy to distribute, entering and analysing the data was time consuming and didn't always give a rich picture of what was going on in the classroom. In contrast, shorter questionnaires with a few open questions meant that it was possible to read through responses to get a good idea about students' attitudes.

"The pre-questionnaire we did on students' attitudes was a big wake up call to the department. We were shocked at just how much students hated science, and this generated a lot of discussion about how we would tackle this."

DO IT!

Try gathering some information about barriers in your classroom by using the questionnaire in the action research toolkit, or convening a focus group with some students in your class.

3 Step 1: Decide on your intervention

Feedback from colleagues

Your colleagues are a significant source of information on the context within your school and classroom. Teachers who took part in action research projects in this area strongly recommended involving others in the department to bounce ideas off as well as to help extend the impact of successful interventions. There are several ways that you could engage colleagues in what you're doing.

- Raise the topic at a departmental meeting.
- Convene an "advisory group" for your project – this could be a couple of colleagues who you can meet with informally at different stages of the project to share your progress.
- Ask another teacher, teaching assistant or senior staff member to observe a class for you, with a specific focus on girl-friendly teaching (they could use the self-evaluation checklist provided in the appendix to this guide, or the checklist in the Red Books).
- Attend a course at your local Science Learning Centre to start discussions with teachers at other schools that are interested in girls and physics.

3.3 Teachers' top tips

You may now have several areas of interest for a potential intervention. Teachers who ran action research projects had lots of tips for other teachers in planning their projects. These related to the interventions themselves and the action research process more broadly. The tips are presented here to help you decide on the intervention you would like to use for your project.

The teachers said:

- make physics relevant;
- remember good teaching practice;
- let students choose an approach that suits them;
- share experiences with colleagues;
- use action research as a tool for change;
- highlight students' voices.

Each of these themes, including teachers' own tips on how to make them work, is described in greater detail below.

Making physics relevant

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 approaches 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".

"Link physics to everyday relevant experiences."

"Show relevance to people and careers – build links into schemes of work."

"Check and counter girls' negative perceptions about abilities."

DO NOT tell pupils *"I'm not very good at physics"*.

DO tell pupils *"everyone can do physics"*.

Remember 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.

Students were empowered by being able to demonstrate their understanding of a concept using everyday language. Structuring groups and assigning roles resulted in greater engagement from students, who were able to remain better focused on the task at hand.

Let students choose an approach that suits them

Related to good teaching practice, some teachers found that an individualised learning approach worked well. 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.

“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.”

Sharing experiences with colleagues

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.

“Work together with colleagues to develop ideas.”

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

Use action research as a tool for change

Teachers agreed that small changes in practice that don't take much time or resources can have a big impact on engagement. Involving students and highlighting student voice greatly enriched the process. Teachers also advised being realistic about the amount of time available for the project. It is useful to set a deadline for feeding back to the department.

“Ask your students what they think.”

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

Highlight students' voices

Teachers were concerned by the extent of pupils' (and girls' in particular) disengagement with physics, but also encouraged by their willingness to contribute their views.

“Being able to talk to students on a one-to-one basis about their learning was very valuable. My teaching of physics has improved.”

Many teachers said that talking to girls about their experiences in physics was the single most effective aspect of their action research projects. 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 different ways to deliver the curriculum.

CASE STUDY: ANALOGIES

“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.

“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!”



3 Step 1: Decide on your intervention

Some teachers went one step further and actually recruited students to help out with the action research. Some students were involved in planning and delivering the interventions, while others collected and collated the views of their peers. Many teachers reported that they found this to be one of the most informative aspects of the project.

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

Several teachers that worked closely with students also found that their students were frustrated about negative perceptions of physics. This led to collaboration between teachers and students, and in some cases the girls’ ideas were much more ambitious than their teachers’. One student that had been involved in this way said:

“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.”

Another important aspect of pupil voice has been in the area of “student peer learning”. Some teachers involved their students in the research process as peer educators, mainly with other year groups at the school but also with feeder primary schools. One teacher specifically recommended that others should:

Use former/current older students to “spread the word”.

DO IT!

Having gathered some information from school and other data, self-evaluation and talking to colleagues and/or students, decide on the intervention for your action research project.

CASE STUDY: STUDENT RESEARCHERS ON GENDER EQUALITY

“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.”





4 | Step 2: Planning action research

What are my research questions?

How will I know if the change has been successful?

Will I use qualitative or quantitative methods, or both?

4 Step 2: Planning your action research project

4.1 Writing an action research plan

Having chosen the “action” for your action research project, it’s now time to think about the research side. This doesn’t have to be onerous, but is crucial to understanding whether or not your intervention worked, and more importantly why.

“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.”

A simple action research planning template is included in the toolkit that accompanies this guide (see section 10). The plan might seem like extra work, but it will help give your intervention the best chance of success. It has several sections:

1. Your intervention
2. Your research questions
3. Indicators of success

4. Research methods

5. Reflecting on and sharing practice

If you’ve followed the guidance above you have already done some work on deciding which intervention is most appropriate, so we’ll skip straight to the research questions in step 2 of the plan.

Setting research questions

The most important part of your plan is your research questions. These are the two or three questions that you will use to guide your project and set out what evidence is needed to measure whether your intervention made a difference or not.

Think of these as the questions you would ask a colleague if he or she had tried out the intervention on their class and you wanted to know if it worked. Example research questions for teachers that tried out a wide range of different interventions are shown below.

Teachers’ research questions for different interventions

- Will knowledge of wider applications of physics in “real life” affect choices made by girls for post-16 courses?
- Can changing my approach improve motivation, understanding and attainment?
- Are girls more likely to contribute ideas in lessons without the expectation that they should use technical terms?
- Does the type of starter to a lesson make physics more relevant to girls? What do female pupils view as relevant illustrations and applications of physics?
- Does encouraging independent work empower the girls to “own” the topic and so become more engaged?
- How will my intervention create an environment where girls will be willing to learn physics and participate in lessons more?
- What are the reasons why girls do not choose physics at our school?
- What careers need physics or find physics useful? Does knowing this change attitudes (student and staff)? Does knowing this help staff make the subject more relevant in lessons?
- How can I use the peer influence of popular girls (and boys) to champion physics for girls?
- How can you improve the confidence/competence of non-specialist teachers of physics? What effect does it have on the pupils?

Indicators of success

In order to answer the research questions it is necessary to have an idea about what success would look like so that you are able to measure it. Teachers in the Girls into Physics: Action Research project used a list of “indicators of success” to help consider this.

Indicators are a way of identifying changes that might occur as a result of interventions. Thinking about them before the intervention takes place will help you anticipate the changes so as to measure them more effectively. However, be aware that some other changes may occur that you might not anticipate, which are also important to look out for. Use this list as a starting point but feel free to add to it.

Some teachers in the Girls into Physics: Action Research project considered using control groups

to see whether differences emerged between, for example, two classes when an intervention was applied to one but not the other. In general, this approach led to inconclusive results: to work effectively, such studies need a large degree of control over many factors and often include very large sample sizes to iron out inconsistencies. It's probably best to avoid this approach for projects of the scale recommended in this guide.

The indicators are split 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.

Who will experience the change?	What type of change is it?		
	Knowledge/skills	Attitudes/feelings	Behaviour
Learners	- Increased attainment in physics end-of-project tests - Students report improved understanding of physics concepts - Raised awareness of linkages between different physics topics - Greater awareness of progression routes - Increased awareness of how physics is valuable in different careers	- Girls' expectations of success in physics matches that of other subjects - Students feel teaching is better tailored to their individual learner needs - Greater appreciation of how physics fits in with the world	- Increased uptake of physics at AS and A2 - More girls state intention of pursuing physics post-16 - Girls and boys contribute to all aspects of the learning experience (behaviour) - Students report higher levels of involvement in class
Teachers	- Increased gender awareness - Increased awareness of the types of careers that interest girls - Increased awareness of physics progression routes - Raised awareness of girls' competence in physics	- Encourage and expect girls and boys to take physics equally - Teachers feel more confident and competent teaching physics to engage girls	Developed practices for introducing careers into lessons
Department/school	- Increased level of gender awareness within department - Raised awareness of physics progression routes and physics-related careers for staff responsible for information, advice and guidance - Move from expectation that post-16 physicists will be selected to expectation that all can participate - Success of new approaches in physics classrooms shared across department and school		

4 Step 2: Planning your action research project

The next sections of this guide focus on the different methods you could use to explore whether or not your intervention was successful in increasing girls' participation in physics.

4.2 Research methods overview

The most popular methods with teachers in the Girls into Physics: Action Research project were questionnaires and focus groups.

Technique	Advantages	Disadvantages
Observation	4 Non-intrusive 4 Can provide very useful insight if conducted by another teacher	8 Observer needs the time to do this 8 Relies on observer's interpretation of events
Interview	4 Can collect in-depth information 4 Interesting responses can be further explored 4 Questions can be explained	8 Potential for interviewer bias 8 Requires skill on the part of the interviewer 8 Time-consuming and expensive
Group interview (focus group)	4 Very rich source of data 4 Possible to observe group interactions	8 Time-consuming and expensive 8 Skilled facilitator required
Questionnaire	4 Inexpensive 4 Quick 4 Easy to gather feedback from lots of respondents 4 Greater anonymity 4 Flexibility with distribution	8 Poor response from students with weak literacy skills 8 Risk of low response rate or "self-selecting" bias 8 Clarification of questions not possible
Secondary sources	4 Generally inexpensive 4 Convenience	8 Validity and reliability problems 8 Data categories may not match requirements

There are other methods you could try. What about using one of the following?

- Teacher peer evaluation
- Diaries/journals
- Video diaries
- Blogs
- Graffiti walls
- Discussions in staff meetings
- E-surveys

4.3 Qualitative or quantitative?

Overwhelmingly, teachers found that collecting qualitative rather than quantitative feedback from students was more useful in this type of action research project. One example was with student questionnaires. Prior to writing a plan, teachers were asked to survey their classes using a short open

questionnaire, which is available in the action research toolkit. For many, this was more enlightening than the longer, quantitative questionnaire provided in the *Girls in the Physics Classroom* Red Book. A good compromise is often to use a few closed and several open questions.

How to design a good questionnaire

Do

- 4 Think about what the information is to be used for and use that to guide you towards a more quantitative or qualitative approach. For example, if the questionnaire is to be repeated after your intervention, you may wish to include some quantitative items. If it's purely to explore attitudes to physics among your class, qualitative items might make more interesting reading.
- 4 Keep questionnaires anonymous to get the most honest responses.
- 4 Explain what the questionnaire is for and encourage students to think about each question before responding.
- 4 Allow enough time in class for students to complete the questionnaires. Rushing through them in a couple of minutes won't give you very useful results, especially if you have included some open items.
- 4 Use neutral wording and balanced response scales (e.g. good – neither – poor rather than excellent – very good – good – OK – poor).

Don't

- 8 Make the questionnaires too long. Students will get bored and you will have to find the time to do all that data analysis.
- 8 Get distracted by things the department would like to find out, so making your questionnaire long and unwieldy. If you can, focus on a few questions that you are most interested in getting feedback on from your class.

Some teachers convened focus groups of girls (or girls and boys) in their classes. Sometimes these were used as a standalone method, and sometimes they were combined with other methods such as questionnaires,

or in one case a “physics graffiti wall” where students were invited to write their thoughts about physics (anonymously) on a board covered in flip-chart paper.

4 Step 2: Planning your action research project

How to run an effective focus group with students

Do

- 4 Explain to the students why their opinions are so important and what their feedback will be used for.
- 4 Focus on two or three questions that you are most interested in.
- 4 Get together on several occasions – before and after you have made the change in your classroom is a good example.
- 4 Encourage the students to be 100% honest!
- 4 Keep it informal so that everyone feels able to share their opinion.
- 4 Record the focus group (with students' consent of course) so you have the option of listening to students' comments again. This will also allow you to focus on facilitation during the conversation itself.

Don't

- 8 Try and cover too much in a short time.
- 8 Worry if you go off on an interesting tangent – the whole point of the focus group approach is that you can explore interesting ideas as they arise.
- 8 Make false promises – be realistic with students about the extent to which you will be able to put their suggestions into action.
- 8 Be afraid – teachers that tried this approach said they were surprised at how well students responded to being asked their opinions!

4.4 Students as researchers

If you have decided to collaborate with students during your action research project, consider asking them to help design a questionnaire or interview other students in your class. Teachers that tried this out during the Girls into Physics: Action Research project found it was a great way to get an honest account of students' views.

DO IT!

You can find a planning template in the toolkit at the back of this guide. After completing it, try talking it through with a colleague or mentor.

4.5 The golden rule

Above everything else, keep the project simple! This is especially true if this is your first action research project. Try out one intervention at a time. It can be tempting to want to change everything at once and while this ambition is admirable, it won't help you figure out exactly what worked.

Teachers that took part in the Girls into Physics: Action Research project recommended:

"Keep it simple to keep it manageable."

"Don't feel that you have to change the world – small changes can have an impact."



5 | Step 3: Do action research

How long should my project last?

How will I engage my colleagues with the project?

What do I do if things appear to go wrong?

5 Step 3: Doing your action research

Completing your action research plan should prepare you well for conducting the project itself. However, even the best plans can go awry, so here are some frequently asked questions or anxieties to help troubleshoot your project.

5.1 How long should my project last?

Teachers who participated in the Girls into Physics: Action Research project had from March to July to complete their projects. Many found this timing difficult due to exams, which actually meant that most interventions actually took place during June and July.

You shouldn't need a long time to try out an intervention, although obviously it depends on the nature of it. A couple of weeks using a new approach should be long enough to get some feedback from students on whether it is working after the initial novelty or change has settled down. This doesn't mean you can't continue the new practice if it's working well! For some teachers this is exactly what happened.

5.2 I'm getting little or no interest or support from colleagues

The extent of this as a problem depends very much on the nature of your intervention. For some interventions (namely those that are classroom-based) it is desirable to have buy-in from the department, but the lack of this doesn't need to stop you changing and reflecting on your own practice, so go ahead and try out the intervention anyway. You may find colleagues will take a greater interest when you have some results to report.

However, if your project is related to workforce or school ethos, collaboration with colleagues is essential. Return to the intervention planning section of this guide and reconsider your choice of intervention – perhaps select another in an area where you have more power to make a change.

CASE STUDY: CAREERS AND RELEVANCE

One teacher told us: "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. 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 PowerPoint on all the possible careers they are interested in looking at further. It was an amazing experience in which I learned 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."

Reflecting on the experience one year on, she said: "Student voice is a large part of school life at [school] so we use it lots. It can make changes for the better very quickly because you get information straight away about your lessons."

"We still use the resources that were made to encourage all groups to participate in physics classes and view it in a more positive way."

You may also wish to monitor changes over a longer time to explore the lasting impact of your intervention.



5.3 My intervention doesn't seem to be working

Unfortunately, there is no guarantee that any of the good practices will work well with a particular group or with a particular school. So the most useful thing you can do in this situation is to figure out why the intervention hasn't worked. For some teachers in the Girls into Physics: Action Research project, other factors intervened to the detriment of the planned intervention. For example, one school introduced a specialist teacher to a class that had built a relationship with their previous teacher for several years. The students were not impressed at the sudden change in teacher. So, even though access to

specialist teaching can help engage girls, introducing this at the expense of other factors had a negative effect. Think about whether this could be the case with your project and use the feedback mechanisms you identified in your plan to explore students' opinions about the intervention. As one teacher said:

"Try things out and if things don't work the way that you expected them to use it as a positive thing, as it can lead to something even better."

When you have learned more about your students' response to this intervention, you may like to try an alternative intervention based on your new understanding.

5.4 What if I end up engaging girls but putting the boys off?

This was a common question during the Girls into Physics: Action Research workshops and led to some interesting discussions about what is meant by gender awareness. There is a difference between orienting examples towards girls only, and using gender-neutral examples. *Girls in the Physics Classroom – A Teachers Guide to Action* includes a discussion of the contexts used in test and examination questions. The table below illustrates this.

Table 2.8: Analysing existing physics questions				
Things to look for	Oriented towards boys	Oriented towards girls	Apparently neutral	Gender inclusive
Content	more relevant to boys' out of school experience	more relevant to girls' out of school experience	abstract, no links to everyday experiences	equally relevant to boys and girls
Format	multiple-choice/short free response/graphical	short free response	short free response/graphical	no format dominating, balance towards short free response
Context	abstract, decontextualised	human, social problem situations	concrete/human experiences (e.g. boys and girls in tug of war)	covers a range of personal and social and environmental situations

Taken from M Hollins, P Murphy, B Ponchaud and E Whitelegg (2006)

Teachers agreed that finding options that would make physics accessible and engaging to both girls and boys was the best way forward. All of the practices referred to in this guide should benefit both girls and boys. As one teacher pointed out:

"The positive benefit is that the things that engage girls are likely to engage many boys too."

So if you are concerned about this; ensure that your intervention aims to be neutral or gender inclusive, rather than oriented towards girls at the expense of boys' interests.



6 | Step 4: Reflect on success

I've collected a load of data – now what?

How do I analyse quantitative and qualitative feedback?

How do I know what the data are telling me?

6 Step 4: Reflecting on success

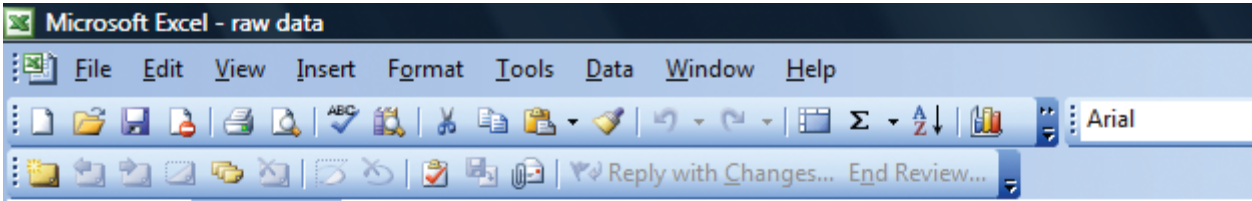
The first step to reflecting on the success of your action research intervention is to analyse the data you have collected from students.

6.1 What do I do with my data?

The easiest way to enter data is into a spreadsheet, such as Microsoft Excel. Enter the data so that each row of the spreadsheet corresponds to one respondent. If you have used questionnaires or structured interviews, number each paper questionnaire or interview schedule. This will give you a unique code and will allow you to double-check responses later if necessary. This number or code should be in the first column of the spreadsheet.

If you are coding your responses numerically (e.g. strongly agree = 1, agree = 2, etc) be sure to make a note of the coding you use. It will save problems if you decide to come back to the data much later, or after staff changes. A good way to do this is to use a separate worksheet in the same Excel file to list the coding you used.

Quantitative data in Excel might look something like this:



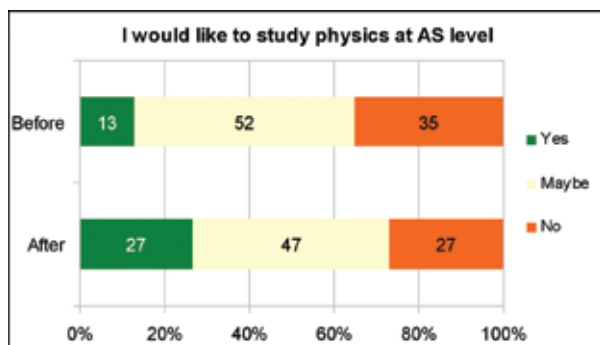
	A	B	C	D	E	F	G	H	I	
201	qreno	schoolno	age	yeargrp	gender	howfeelA	museum	howgood	interesA	gdr
202	195A	2	13	8	1	1	2	2	2	
203	196A	2	13	8	1	3	3	2	2	
204	197A	2	13	8	1	3	2	3	2	
205	198A	2	13	8	1	2	2	2	2	
206	199A	2	13	8	1	2	3	2	2	
207	200A	2	13	8	1	2	5	3	2	
208	201A	3	14	9	1	4	1	4	4	
209	202A	3	14	9	1	2	2	2	2	
210	203A	3	14	9	2	3	1	3	3	
211	204A	3	14	9	2	3	1	3	4	
212	205A	3	14	9	2	3	1	3	3	
213	206A	3	14	9	2	4	1	4	4	
214	207A	3	14	9	1	3	2	3	3	
215	208A	3	14	9	1	3	2	3	3	
216	209A	3	14	9	1	3	2	3	3	
217	210A	3	14	9	2	3	1	3	3	
218	211A	3	14	9	2	4	1	3	3	
219	212A	3	14	9	1	3	1	2	3	
220	213A	3	14	9	2	3	2	3	2	

If your questionnaire/interview included some open items, you can enter them into the spreadsheet in the relevant row. You can then compare responses to the closed and open items.

6.2 How do I analyse quantitative data?

The first step in analysing quantitative data is to look at frequencies, e.g. how many people ticked the different boxes on a questionnaire. Use the “countif” or “frequency” functions in Excel to do this – type the function into the help box if you are not familiar with it.

You can then create histograms (the most appropriate way to present ordinal data) from your responses. Stacked bar charts are a concise way of presenting responses to multiple questions that had the same response scale, as with this example from one of the Girls into Physics: Action Research projects’ survey of Year 9 students (“before” and “after” refer to before and after the intervention. The numbers in the bars are the number of responses).



6.3 How do I analyse qualitative data?

Qualitative data are less straightforward to analyse, because responses are more likely to give a deeper impression of respondents’ opinions. All qualitative analysis looks to identify common themes in the responses – known as “coding” the responses. It can be useful to think about what codes you might use before you sit down with your feedback. For example, are you interested in how a new approach affected girls’ understanding of particular concepts? Or is it more about their confidence and engagement in

lessons? Think of some words you could use for your codes, it can be useful to make a short list of these. If you spoke to the students yourself, you are likely to have a good idea of what the codes might be before completing the analysis. Alternatively you may wish to group similar responses together first and think about how you would label the groups afterwards.

A simple way to code qualitative data is known as category analysis, which involves grouping similar responses (for example from an open questionnaire item) into categories. You can then count the number of responses in each category. This can then be used to compare results, for example between girls and boys or before and after an intervention. If your data is in an Excel spreadsheet, copy the cells containing the responses and paste the text into a Word document. You can then drag and drop to group similar responses together. When you have identified several groups, think about how you might label them – the labels are then your codes.

If you have interview or focus group data, you may have handwritten notes or a typed transcript instead of columns in spreadsheets. If this is the case, take a photocopy of the originals to use while coding the responses – this will mean that you have free rein to scribble on it where you wish. If possible, leave a wide margin on one side of the page to jot down thoughts or ideas. You can write notes in the margins then organise these into codes, or use different coloured highlighters to identify different themes, or cut up the (photocopied) document and organise the slips of paper into piles. It’s up to you.

The box below shows how part of a focus group transcript could be coded using a combination of highlighters and some notes in the margins. The transcript is fictional but is based on a real discussion that took place during the Girls into Physics: Action Research project.

6 Step 4: Reflecting on success

Example transcript excerpt

Teacher: OK so what about when we did the comparison between the different cars, looking at their power and mass and top speed, what did you think about that?

Dean: I liked that, I like cars so it was good.

Aimee: I like cars, but I wasn't too sure about that lesson.

Teacher: Why do you say that?

Well I just couldn't see what the point of it was really, like I didn't understand what all the different facts about the cars were and they all had different numbers and it was pretty confusing.

Leanne: In our group, we thought it was OK but we just got on with it so we could put the answer in.

Dean: In my group we just liked going on the internet and looking at all the websites for the sports cars.

Teacher: So how could I have made that lesson more interesting?

Leanne: I dunno, maybe if like if it had more to do with like what we were interested in.

Sofia: Like what about if you made it more of a challenge and said we won the lottery or something and we had whatever amount of money and we had to try and buy a sports car with the most efficiency or horse power or whatever.

Dean: Yeah or you could have different groups buying different cars for different reasons or countries or something.

Codes and comments

Response to gendered examples

Relevance

Goal-oriented approach

Girls seemed more switched off by lack of relevance than "male" cars example

Boys and girls sound like they could be better engaged with a real-life scenario

You can code in as much or as little detail as you like (or have the time for). It works well to go over the data briefly first, getting an idea of the big picture, then coming back to certain ideas again later if you get the chance.

6.4 Help! I have collected loads of data and I don't know what to do with them

Many teachers experienced this during the Girls into Physics: Action Research project – it is especially easy to collect a great deal of detailed questionnaire data. The data then need to be entered by hand and analysed, a time-consuming process that was too much for some.

The first thing to do is prioritise. What are the key questions that you need to answer? Do you need every piece of feedback you have collected to answer this? Hopefully the answer is no. So you could just focus on the questionnaire items, etc that are most relevant and ignore the rest, or save them to come back to another day.

Also, the purpose of the action research approach is to provide tools for you to reflect on your own practice, not to add to your workload. If entering and analysing the data from the questionnaires is going to take too long, an alternative approach is to set aside an hour or so to read through the responses and jot down any thoughts or reflections of your own based on the students' feedback.

6.5 How do I know what the data are telling me?

So now you have analysed your data, it's time to figure out the story they are telling you. This is where the research questions you wrote in your plan come in. Go back to those questions and try and answer them based on what you now know.

CASE STUDY: IMPACTS OF ACTION RESEARCH

One teacher worked with students as researchers to try and help girls see the relevance of physics. The intervention was focused on the triple science class of 26 girls, who “were students who had high ability but would not necessarily choose physics for an A-level subject”. She described the process of working with the students as an “incredibly positive and worthwhile experience...The positive effects on motivation are huge, leading to a healthy open learning environment.”

The students reported a greater interest in physics while in Year 11 and this has now translated into improved uptake at A-level. She said: “The class I worked with had 26 students. Five girls have remained at our school to do physics. Some students have moved to sixth-form colleges and are continuing with their physics studies there although I am unsure of the exact number. One student won a physics scholarship to an independent school in the area and has continued her studies there.”

The teacher is now planning her next action research cycle: “I have been doing some work with non physics specialists on how to approach teaching mathematical relationships within physics to girls. We have been looking at how to let the girls work out the relationship practically themselves and describing the relationship before introducing the mathematical representation of the relationship between variables. I am using this as a basis for a further action research project.”

It is useful to write a brief report following your action research project. The template in the toolkit has just five headings to reflect on. Writing about your findings can help aid the reflection process and provides a record of your activities for your own purposes in the future. It is also a great way of sharing your experiences with colleagues.

DO IT!

The toolkit that accompanies this guide contains a brief report template (see section 10). Set aside some time to complete this and reflect on your action research.





7 | Step 5: Share learning

What is the best way to communicate my research findings?
What next?

7 Step 5: Sharing learning

7.1 What's the best way to communicate my research findings?

Teachers from the Girls into Physics: Action Research project felt that the impact of their projects could be extended by discussing their experiences and findings with colleagues. Teachers tried several approaches to this:

- informal discussions with individual colleagues;
- presentations at departments and senior management meetings;
- sharing resources, e.g. equipment and video presentations;

- formally writing up findings, e.g. using TLA;

- making films where students shared their ideas.

Highlighting student voice, when sharing findings, is a powerful way of changing practice. One teacher had identified, through a focus group, that girls were getting the idea that physics was difficult through comments from other teaching staff. Using direct quotes from students in his presentation to the department allowed him to send a strong message to colleagues.

In other cases, a less formal approach was taken, but leading by example allowed successful practices to be picked up.



CASE STUDY: SHARING PRACTICE

One teacher tried out mini whiteboards as an inclusive questioning technique in class. She described the impacts of the change in practice on her and her class: “I feel more confident about my ability to teach physics, and particularly in a way that is engaging for all of my students – boys and girls. In addition, some of the techniques that I was looking at, e.g. using mini whiteboards and other methods of individual feedback, have become second nature and I use them right across my teaching.”

While this was not shared formally with others, individual discussions and the provision of an extra set of the whiteboards means “this is becoming a more widely used teaching method”. This is an example where a small change in practice can begin to spread across a whole department.

While these case studies are positive examples, an action research intervention does not always work. Some teachers in the project found it difficult to establish whether the intervention had made a difference or not, while others students actively disliked the new approach.

Sharing what worked – and what didn't – with colleagues will help share good practice and prevent mistakes being repeated. They can also help you understand the reasons why an intervention didn't work as well as you had hoped, which can feed into the planning for the next change.

To share your successes with other teachers and engage in discussion, you can visit www.talkphysics.org and join the Institute of Physics Girls in Physics group.

7.2 What next?

Action research is a cyclical process. After completing your project you are likely to have identified lots of other areas where you could make further changes to increase girls' participation in physics. In fact there is no need to even be limited to the question of girls' participation.

CASE STUDY: ACTION RESEARCH BEYOND GIRLS AND PHYSICS

Many teachers that participated in the Girls into Physics: Action Research project have continued to use action research in their teaching. For some, the approach has been extended to engage a range of groups with physics, as one teacher said: "I am continuing with girls into physics now encouraging all into physics. I have also tried to carry out some action research with a difficult class in science looking at ways to motivate them. I used them to inform me of the activities that they wished to carry out and designed lessons to meet their needs." The idea of working closely with students to promote engagement is also being used by another teacher, who has continued to work with her group of student researchers: "I am currently looking at questioning techniques with Year 10 triple award groups. I am using research students to observe my lessons and look at the results."

One teacher is even using the approach to explore ways of engaging boys in science more generally: "I have been researching the impact of using PE in the science lesson. I have been trying to interest disaffected boys in science." Another is working with students lower down the school: "I am currently working on a project looking at dialogic teaching in physical science and maths. With teachers from a number of schools and university researchers we are developing modules for teaching forces and electricity in Year 7, using a dialogic approach."

However, they were keen to recommend the "keep it simple" approach to other teachers. One summed it up by saying: "Spend time thinking about what you can feasibly do in the time you have available."



Go ahead and start the process again!

8 Action research glossary

Is it another language? We hope not, but just in case...

Action research: a cycle of planning, doing and reflecting on a change in practice.

Coding: the process of identifying themes in qualitative feedback.

Girls into Physics: Action Research project: an Institute of Physics programme that aimed to increase girls' participation in physics.

Indicator: something that you can measure to establish whether a change has taken place.

Intervention: the change in practice that you make, for example to try and encourage greater participation in physics from girls.

IOP: Institute of Physics.

Qualitative: research methods that allow respondents to describe their thoughts and experiences in their own words.

Quantitative: research methods that count how many respondents hold a particular opinion.

Red Books: two publications (a review of the literature and a teachers' guide to practice) that arose from the Institute of Physics' Girls into Physics programme of work.

Research question: a broad question that you set yourself when planning your action research project to focus the project.

Respondent: someone who provides feedback for your research project, e.g. a student who completes a questionnaire.

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Action research toolkit

Contents:

- Self-evaluation checklist
- Physics questionnaire
- Diamond 9 Ranking activity
- Action research planning template
- Action research brief report template

10 Action research toolkit

Self-evaluation checklist

This self-evaluation checklist lists various gender-aware teaching practices. It's a simple starting point to identify possible interventions for your action research. Work your way through this list and circle whether the practices happen often, sometimes or rarely in your classroom or school.

Physics learned (and taught) in a way that is accessible and engaging for girls			
Gender-neutral illustrations and examples used	Often	Sometimes	Rarely
Non-technical language and analogies used where possible/appropriate	Often	Sometimes	Rarely
Context provided through linking topics and highlighting applications and social relevance	Often	Sometimes	Rarely
Variety of questioning techniques used and thinking time and discussion built into activities	Often	Sometimes	Rarely
Classroom managed to promote girls' engagement in group work			
Roles assigned for practical work to promote engagement	Often	Sometimes	Rarely
Differentiation between social and learning groups	Often	Sometimes	Rarely
Students grouped for teaching and learning, not classroom control	Often	Sometimes	Rarely
Progression routes visible			
Teachers aware of students' ability and confidence levels in physics	Often	Sometimes	Rarely
Information, advice & guidance (IAG) provided reflects the range of routes into physics post-16	Often	Sometimes	Rarely
Relevant careers promoted			
Careers that interest students have been identified and promoted	Often	Sometimes	Rarely
Links to careers made within class	Often	Sometimes	Rarely
Workforce: girls (and boys) access good physics teaching			
Physics staff are supported in development	Often	Sometimes	Rarely
Specialist teaching is accessed pre- and post-16 to give continuity	Often	Sometimes	Rarely
Workforce is effectively deployed to teach physics	Often	Sometimes	Rarely
Ethos of "physics is for everyone": positive perception of the subject in school			
Positive school culture identified, e.g. through Ofsted	Often	Sometimes	Rarely
There is support for physics at senior level in school, e.g. flexibility with timetable	Often	Sometimes	Rarely
Staff and students are proactive in discussing physics options	Often	Sometimes	Rarely

Physics questionnaire

We are interested in what you think about your physics lessons. Your answers are anonymous so please be honest.

Please circle – are you: Male Female

1. Can you think of a specific physics lesson where you felt that you learned a lot?

2. What was it about that lesson that made you feel like you had understood what was being taught?

3. What particular topics in physics do you find difficult or boring?

4. Can you think why these are particularly hard to learn?

5. Do you have any other comments about your experiences in physics lessons?

10 Action research toolkit

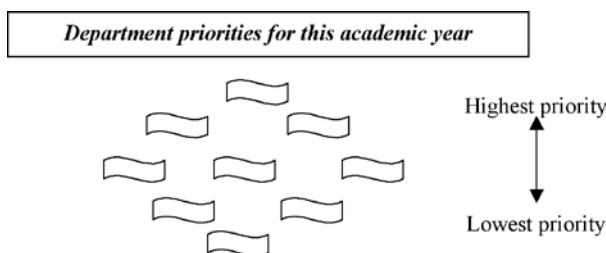
Diamond 9 ranking activity

This activity will help you to consider each of the clusters of good practice indicated in *A Teachers' Guide for Action* (Hollins *et al.* 2006 4–9). This activity would be most usefully conducted at a planning stage with colleagues in your team/department.

Either choose an area that you would like to focus on, or use all of the points to identify which interventions appeal. Copy the bullet points on a separate page and cut up into sections with a message on each. Feel free to add your own ideas. Consider each point in turn and rank in a diamond pattern, for example according to one of the following factors:

- which you think is most important to tackle now;
- which has the most potential for change with current resources;
- which is most important for you to respond to in your classroom/school.

Be prepared to challenge some of the messages and test them out for yourself. Stick the diamond on a page and review at the next team/department meeting.



The school culture and ethos

What is it about some schools that make them so successful at recruiting girls into physics and is this quality transferable?

- Accentuate the positive wherever possible and avoid portraying physics as an essentially hard subject.
- Take positive steps to reduce the impact of stereotyping. All staff, not just physics teachers, need to be well informed about the issues. In particular, teachers must avoid reinforcing stereotypes, endeavouring not to use mostly

male examples when talking about occupations or interests.

- Make sure that physics is viewed as a valuable subject in its own right, not just regarded as a qualification for careers in science and engineering.
- Encourage collaborative approaches to the teaching and learning of physics and avoid domination by individuals.
- Invite staff to be proactive in discussing study options. They should not just give information; they should give an insight into what studying physics will be like. Involve A-level students and encourage them to give an honest appraisal of their experience.

The curriculum and its organisation

What can schools do to make the science curriculum more gender inclusive?

- Avoid fragmenting the pre-16 science curriculum more than necessary; plan to make explicit links between related areas. The use of "mind/concept maps" or group preparation of displays summarising a topic may be a useful approach.
- Give weight to continuity of specialist teaching when timetabling. If possible, enable pupils to experience the teaching style that is likely to be used post-16.

Classroom management

How can teachers vary their classroom organisation to encourage full participation by girls?

- Distinguish between social (seating) groups and working groups and change the latter periodically.
- Try out different groupings for most practical work and discussion, perhaps including single-sex groups as part of an overall strategy for improving participation.
- Ensure that all girls play an active part in activities and do not just act as note takers.
- Group students according to their learning needs not for classroom control.

Questions and answers

How can teachers frame and address questions in ways that will encourage girls to respond and to articulate their understanding and concerns?

- Decrease the use of hands-up, closed, rapid-response questions.
- Encourage the view that there is not always a unique correct answer.
- Give pupils the privacy and confidence to take risks when answering questions.
- Try whiteboards for quick, individual responses.
- Invite group discussion with a spokesperson as a way of lowering the stakes and encouraging collaborative learning.

The use of language

Is there an unwitting gender bias in the use of language in physics? If so, how can this be diminished?

- Don't use non-essential technical language or formulae as shorthand for physical laws during the early stages of learning.
- Use pupils' own everyday language as far as possible and encourage them to do the same until concepts are well established.
- Ensure that essential terminology is clearly defined and used in context, and that understanding is checked.
- Reinforce underlying physical principles first rather than starting with formulae.

The use of analogy and illustration

How can teachers help pupils – girls in particular – to have appropriate mental pictures of ideas in physics and how these relate to the observable world?

- Make sure that illustrations draw on the experience and interest of girls as well as boys. (A shower curtain that seems to “cling” in the shower counts as a common experience; bending the path of a football does not.)

- Be careful not to make excessive use of mechanistic illustrations, which may be outside the experience of girls.
- Avoid being overcautious about the use of analogies; some mental picture is usually better than none.
- Don't assume that the basics do not need demonstrating through practical work.

Relevance

What can teachers do to ensure that girls view physics as relevant to their lives?

- Try to give pupils a glimpse of the “big picture” by reinforcing links between topics, key ideas and applications wherever possible.
- Try tackling applications first and then principles so that the rationale for studying a topic is clear throughout.
- Supplement standard texts with other reading material, such as articles or newspaper cuttings, to introduce the social relevance of physics.
- Use the internet to introduce contemporary applications of physics.

10 Action research toolkit

Action research planning template

1. Your intervention What are you going to change in your classroom, department or school? When and how will you do this?
2. Your research questions What questions will your research project aim to answer?
3. Indicators of success What will success look like?
4. Research methods How will you measure any changes in your indicators to answer your research questions?
5. Reflecting on and sharing practice What methods will you use to analyse the feedback that you collect? How and when will you share this with colleagues?

Action research report template

1. Project rationale

What was the reason that you decided to take action? What factors led you to choose the area for your intervention?

2. Your intervention

Describe the intervention.

3. Did it work?

Answer the research questions that you set yourself in this section.

4. Implications

What does this mean for your teaching and the department/school more widely? Will any changes in your practice be sustainable? What learning can be shared with colleagues?

5. What next?

Now that this area has been addressed, you can return to the start of the cycle and plan another intervention. Based on your findings, what do you think should be changed next?

Notes





Girls into Physics: Action Research

A practical guide to developing and embedding good classroom practice

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