An Institute of Physics Report | **March 2017**

# Improving Gender Balance

## Reflections on the impact of interventions in schools

**IOP** Institute of Physics

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# Foreword

Physics asks key questions about the universe, and endeavours to create effective models of how it all works. Quite naturally at the Institute of Physics we wish to see more people engaging with the excitement and wonder of the new insights that physics brings, and then – if they feel it suits them – studying physics to as high a level as they can.

Of course we would not expect everybody to have the same enthusiasm as we have. Inevitably, many people will have interests that lie elsewhere. But for more than two decades only a fifth of A-level physics students have been girls. It is very worrying that many girls are being put off the subject at an early age and thereby are being denied the opportunities, excitement and vision that it embodies.

It is a particular passion of mine to inspire more people to engage with physics, to increase the diversity of those who appreciate the wonder of the universe and how it all works, and to enjoy this subject of ours – a discipline that questions so deeply, informing and enlightening as well as underpinning many of the innovations that impact our daily lives.

I find the IOP's endeavours to date in this area heartening, with positive results coming out of the work done by our education team over the past 10 years. And yet it is clear that much more needs to be done to enthuse more girls into wanting to experience the pleasures, excitement and benefits of a physics education.

Our recent studies have pointed to unconscious biases and cultural stereotyping as possible reasons for this continuing gender imbalance, and they indicate that an embracing culture within the whole of a school is an important factor. Our latest project, Improving Gender Balance, and the pilot funded by the Drayson foundation trialled different interventions in schools and looked at the impact they had.

This report sets out the results and recommendations from that latest work, and will inform our continuing efforts to break down barriers and ensure that students are truly free to choose subjects based on their own aptitudes and interests – and if they choose, to find fulfilment in physics.

**Professor Roy Sambles FRS CPhys FInstP**
President, Institute of Physics

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# Executive summary

For more than 30 years only a fifth of those taking A-level physics have been girls.

Over that period every effort to increase uptake has failed. Uptake of A-level physics among girls has remained at about 20%. The various methods tried clearly haven't worked at a national level.

Meanwhile, our analyses have found striking differences in uptake in mixed-sex state-maintained schools compared with single-sex schools. The type of school affects the rate of uptake of physics. Further research showed the extent to which gender stereotyping can occur in schools, and how it can create barriers to subject choice.

From our research and recent pilot projects, we can deduce that further work to increase girls' participation in physics should – at least in part – operate across the whole school, involving students, teachers of physics and of other subjects, senior leaders, parents and governors. And it should tackle biases and stereotyping.

Our latest gender-balance projects trialled interventions of this type. Each strand of these projects had some positive impact, and a combined approach had a transformational effect, with the number of girls taking AS-level physics in the participating schools drastically increasing from 16 to 52 – more than trebling over two years.

# Main recommendations

To make a significant difference to students' perceptions, work needs to be done across the whole school to challenge gender stereotypes and support interventions in physics lessons. We recommend that schools combine the following in a blended approach.

- Appoint a gender champion – someone senior in the leadership team who is able to drive change within the school
- Analyse progression data by gender for different subjects and discuss what might be driving any gendered patterns
- Train teachers to understand unconscious bias and how the experiences of boys and girls may differ because of it. Have physics teachers adopt more inclusive teaching practices, which can have a big impact on progression rates. Equip them to deal with sexist comments and bullying
- Raise students' awareness and engagement of the gender stereotypes they face and engage them in addressing them
- Review the options process: look at the options information and presentations through a gender lens and equip students to engage critically with the process
- Consider project-led science clubs to encourage a better gender balance

# Introduction and background

Girls have long been under-represented among those who choose to study physics beyond the age of 16.

For decades, only a fifth of those taking physics in England have been girls – even though both genders perform equally well up to age 16. Many girls who might have enjoyed the benefits of a physics education miss out.

The Institute of Physics believes that all young people are culturally entitled to an excellent and authentic experience of physics up to the point at which they make a choice to continue studying it. The low uptake of physics among girls suggests to us that many of them are being denied that entitlement in some way.

It is therefore a goal of the IOP to make the system more open and redress that gender imbalance. The Institute has investigated the likely causes and possible solutions for more than a decade. We published a research review and accompanying best-practice guide for teachers, Girls in the Physics Classroom, in 2006.

In its 2012 report It's Different for Girls, the IOP revealed that around half of maintained co-ed schools sent no girls on to take physics A-level, and uptake was much higher in single-sex schools. This suggests that the type of school has an impact on progression rates.

That report recommended that schools actively challenge gender stereotyping, recognise misconceptions about girls' abilities in subjects such as physics, and be aware of teaching styles that better suit boys or girls.

The 2013 report Closing Doors presented data on several subjects with gender imbalances and showed that schools that have imbalance in one subject tend to have imbalances across the board. That led us to believe that gender imbalances in physics were indicators of problems across the school, rather than existing in isolation.

And yet some schools managed to achieve much more balance in their progression rates across subjects. This suggests that the whole school environment affects subject choice. Closing Doors therefore recommended that schools should counter gender stereotyping by working across the whole school, involving students, teachers, senior leaders, parents and governors.

In 2015, the Government Equalities Office co-funded the IOP's Opening Doors project and resulting report, which offered guidance on breaking down the barriers to gender equality in schools. The guide highlighted issues that many schools deal with on a daily basis and presented suggestions for schools facing similar barriers, including nine essential features of schools that actively tackle gender equity, from training and data use to combatting sexist language.

Meanwhile, the Stimulating Physics Network (SPN) – an IOP project funded by the Department for Education – has been running in state-maintained secondary schools in England since 2006, with the aim of increasing A-level uptake by improving the teaching and learning of physics.

The number of students choosing to continue with physics after the age of 16 has been increasing in SPN partner schools, with the effect particularly marked for girls. In 2014, the project saw a 32% increase in the number of girls in these schools progressing to A-level, with the average proportion of female students in physics classes moving from 17% to 23%, better than the national average for state schools.

But while better teaching can and does improve progression rates, it only works up to a point.

To make a substantial difference in the number of girls taking physics A-level, we need to look beyond the science department to the whole school.

The Improving Gender Balance (IGB) project was launched in 2014 as part of SPN and ran until 2016, looking at factors beyond physics and testing different interventions in schools and comparing them against one another.

Over the same period, a pilot project funded by the Drayson Foundation investigated the cumulative impact of multiple interventions on the progression of girls to physics beyond the age of 16.

This report sets out the forms those interventions took and the results they gave, and presents recommendations on how to improve gender balance in schools based on what was learned.

# The IOP's work in schools

## The projects

The IGB project, funded by the Department for Education as part of the Stimulating Physics Network, began in September 2014 and ran in 20 partner schools for two years. Each school took part in one of three distinct strands:

- **Strand A** – improving girls' confidence and resilience. Eight schools were supported by two project officers. Each officer worked two and a half days a week, and schools tended to be visited fortnightly.

- **Strand B** – working in the physics classroom. Eight schools were supported by two project officers. As with strand-A schools, each officer worked two and a half days a week, and schools tended to be visited fortnightly.

- **Strand C** – a whole-school approach. Four schools were supported by three project officers. Each school had two days of officer time dedicated to them every week, which included both contact and preparation time.

We also ran a pilot funded by the Drayson Foundation.

- **Drayson pilot** – this operated in six schools, combining the different strands from the IGB project and adapting them to schools' individual needs. The Drayson officer worked with the schools three days a week.

## Aims

Given the factors that seem to be important in influencing subject choice, the IOP's gender-balance projects were designed to:

- Improve the experience of girls in the physics classroom and make sure that girls are not being denied opportunities based on social expectations of their gender

- Enable students and staff to understand and address the impact, on themselves and others, of their unconscious biases and stereotyping

- Enable girls to develop their science identity and confidence

The project's activities took several different forms, described in the following pages. The uptake of physics beyond the age of 16 is hard to measure effectively, since schools that only teach students up to the age of 16 don't measure progression rates consistently. Progression data for a school is possible to obtain by looking at the National Pupil Database. However, it can take several years to get data when we start working with students/teachers at KS3.

Therefore, results are presented based on each strand's key performance indicator (KPI) using baseline data from autumn 2014 where available, and the results of two surveys in March 2015 and March 2016.

The remainder of the results of, and lessons from, each strand are based on a series of qualitative surveys carried out by an independent evaluator, as well as feedback from the project officers.

# Strand A: improving girls' confidence and resilience

As revealed in the IOP's 2006 report Girls in the Physics Classroom, girls can sometimes lack confidence in their ability in physics, despite the fact that they do well.

From work by the education researcher Patricia Murphy and by the psychologist Carol Dweck, we know that boys tend to attribute success to their own efforts and failure to external factors, whereas girls do the opposite, and if they fail, find it particularly debilitating as they believe it's because they aren't able. This lack of resilience can lead them to avoid challenges or subjects such as physics that are perceived as especially difficult.

Strand A therefore focused on building confidence and resilience (the ability to adapt appropriately when faced with disadvantage or adverse conditions).

It involved working with girls at Key Stages 3 and 4 in eight schools in the north east and the midlands of England. The activities may also have increased science capital.

## Activities

The following types of confidence-building programmes were developed as part of this strand, all of them aimed at year-9 and year-10 girls.

> They are growing in confidence. They had been reluctant to be seen to be involved, for example, just being seen doing activities. But they have now enjoyed the activities.
>
> **Lead teacher, strand-A school, 2016**

### Science ambassador training

This began with a training day for year-9 girls, who would become science ambassadors in primary schools. Students from several schools in the surrounding area could attend the training.

The girls worked in mixed-school groups during the day with a mentor – a volunteer from industry. They carried out a variety of tasks designed to build their presentation and science demonstration skills and raise their confidence. On returning to their own school, they worked together to develop workshops that they could run with primary schools.

As well as increasing the secondary students' propensity to trust in their own decisions and boosting their science identity, running workshops with primary schools also developed links with feeder primary schools, and is likely to have had some impact on the primary pupils – although that wasn't measured during this project.

Year-10 girls developed activities to take to one of the feeder primary schools. Two of these girls used the science leadership skills they developed for their Duke of Edinburgh bronze award. Expectations included taking a more active role in running the preparatory IGB sessions and leading the sessions in the primary schools. The head of department invited the head teacher to see the activities running in the primary school, commenting: "The project is going fantastically well. The girls are a real credit to themselves and to the school." The primary teacher added: "I had very positive feedback at parents evening, saying our children are loving it."

### Extracurricular clubs

Extracurricular clubs were run in eight schools. Most took place after school or at lunchtime and were voluntary. In one school they took place during PSHE lessons, and in another during half a science lesson and form time.

The project officers ran a range of sessions on science-based leadership skills including creativity, problem-solving, and so on, but some sessions also addressed issues of gender stereotyping, careers and mindsets (see below).

Further activities were chosen by the group themselves. The girls overwhelmingly chose to develop science outreach activities to run for younger students. Outreach opportunities included after-school or lunchtime clubs and primary induction days. Some groups also included aspects of gender equality in their workshops. Other schools carried out action research in their school and primary workshops around gender equality.

## Mindset

"Growth mindset" is the name given by psychologist Carol Dweck to the idea that intelligence can develop, and that effort leads to success.

**Open mindset:** A student believes they can improve.

**Closed mindset:** A student believes in natural talent.

Stereotypes – for example the idea that boys are naturally clever and girls are hardworking – may contribute to forming a closed mindset. Students with an open mindset are more likely to improve.

### Outside speakers

Girls had opportunities to hear outside speakers, including by having the speaker come to a lunchtime session, girls visiting different venues, and featuring a speaker at a science evening organised and run by the group in school.

### Results

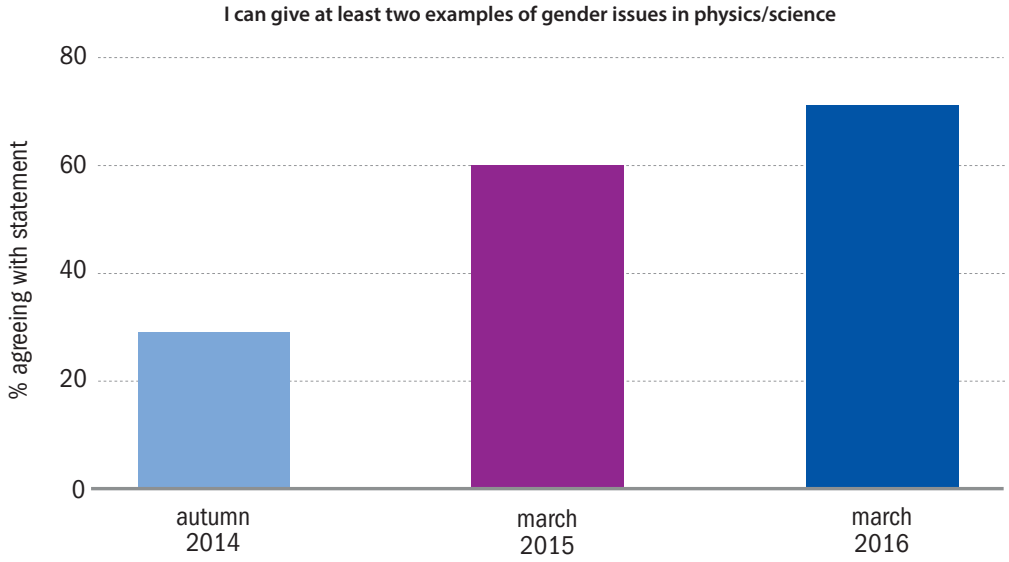
Participating girls and their teachers were able to list a range of transferable skills that the girls attained, including critical/logical thinking, presentation skills and practical skills, and attributed an increase of confidence to the programme.

One particular benefit of this strand is that as well as developing confidence it helped students to develop a science identity and increase their science capital. A student's identity is often defined by the activities they choose to take part in, such as sports or music, and the activities in this strand might appeal to girls who may not be interested in a more traditional science club.

It is noteworthy, too, that these are more than just single-sex science clubs. In all the activities that formed part of this strand, the students drove the clubs forward, developing their leadership and teamworking skills through setting the agendas and deciding priorities. These clubs were not just a space in which to try things out, but also a club over which the girls had real ownership.

> Before, I'd never realised there was a gender gap. It introduced the idea to me.
>
> **Year-11 girl, strand A, double science, 2016**

**Strand-A KPI:** engaged girls report increased awareness of gender issues and influences on subject. Source: IGB project evaluation.




With regard to strand A's impact on increasing the number of female A-level students, it's a little early to say. A number of teachers saw it as a useful tool, but not sufficient on its own to make a large increase in numbers.

### Lessons learned

Strand A focused on girls who were in years 9 and 10 during the first year of the project, and who moved up to years 10 and 11 during its second year. Many teachers and some participating girls felt that it would have had a greater impact if it had targeted younger girls – many of those in year 10 and above already had a clear idea of what subjects they wanted to take at A-level.

> The most pleasing aspect is to see the growth of confidence. For example, two girls in year-10 science were fairly quiet and wouldn't get involved and took a back seat, but now they have got more confidence and have changed their attitude to science positively... they are more proactive in seeking help [in physics]. Before they wouldn't have asked.
>
> **Lead teacher, strand-A school, 2015**

From research carried out as part of ASPIRES, a longitudinal research project studying young people's science and career aspirations, based at King's College London, we also know that even if girls like science and find it interesting, few of them aspire to be scientists. As described in the report of the ASPIRES project published in 2013, another contributing factor is low science capital – the sum total of what science they know, their attitude to science, who they know (and their interest in science), and the degree of everyday engagement with science. Girls who do aspire to scientific careers may require considerable resilience to maintain those aspirations.

> I have chosen to take [physics] at A-level. I was 50:50; it has helped.
>
> **Year-11 girl, strand-A triple science**

In the new phase of this work we're trialling the extracurricular clubs and science ambassador activities with younger years, perhaps years 7–9, with graduation onto real research projects in years 10 and 11.

The science ambassador days were most effective when they ran at the start of the intervention. Most impact was achieved when schools spent time with students and included follow-up sessions using the skills developed on the day, for example primary-school science outreach. We recommend that a science ambassador coordinator takes overall charge of this.

### Main lesson

Interventions such as these should be targeted at girls younger than those in the pilot.

> It's going to have a small [reach] because of the small number of students involved, but what has happened is high impact on those small numbers.
>
> **Lead teacher, strand-A school 2016**

# Strand B: working in the physics classroom

Strand B involved working with teachers of physics to improve girls' experiences in the physics classroom in eight schools in the east of England and in the Yorkshire and Humber region.

Since 2006 the IOP has worked to improve the teaching of physics in more than 400 English state-maintained schools through the Stimulating Physics Network. Those schools have significantly more students than average choosing to continue with physics post-16, and the effect is particularly pronounced for girls – suggesting that they're more affected by the quality of teaching than boys are.

Nevertheless, even when teaching is better overall, girls' experiences of the physics classroom can still differ from those of boys, as shown in the IOP's 2006 report Girls in the Physics Classroom.

Our action-research project from 2008, the results of which were published in the report Girls into Physics the following year, found that some of the most successful approaches to making physics more relevant to girls included:

- Adopt inclusive teaching techniques in physics lessons
- Integrating physics-related careers in class (such as through direct references, set assignments, posters and displays in the classroom)
- Creating opportunities in lessons for students to explore the social relevance of physics (including the roles of physicists)
- Work experience and examples of physicists were also effective in bringing physics to life

Bearing these lessons in mind, Strand B was aimed at getting a better understanding of why girls' experiences of the physics classroom differ, and working with teachers to devise and adopt ways in which girls' experiences can be improved.

## Activities

### Data analysis

Data was used to stimulate discussions in departmental meetings around what could be done to improve the gender balance post -16 for physics. Departments looked at the gender balance of the students' progression post-16, compared it to the national average and planned whether any actions are necessary.

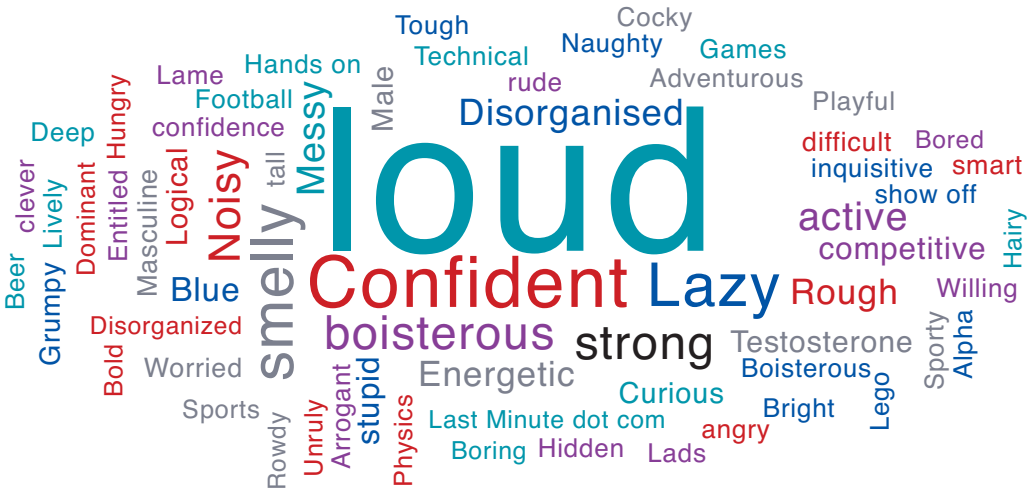
Departments also analysed data for streamed classes – for example on whether there are gender imbalances in the highest or the lowest stream of a subject, and whether this was reinforcing any gender stereotypes or gendered behaviour.

> Year 9s and 10s are more engaged. It's a nice change to have to stop girls talking and their conversation is about physics.
>
> **Lead teacher, strand-B school 2016**

### Unconscious bias training for teachers of physics

Unconscious bias is at the core of understanding where gender stereotypes come from, and allows teachers to reflect on what is happening in schools without pointing fingers. Teachers were given training around unconscious bias and were able to try out an unconscious bias test online. They were then given guidance around how they can manage their unconscious biases in the classroom.

**Give me three words you would associate with boys**




**Give me three words you would associate with girls**


Anyone can test online whether they have a bias. If one associates maleness and science, seeing femaleness being equated with science may lead to that notion being rejected, as it doesn't fit an established pattern. This can lead to some teachers having lower expectations of their female students in science, or believe them to be hardworking but not innately good at physics, or have double standards regarding the presentation of work. The reverse can also be true, as with boys and English. Once someone understands their biases, they are often surprised that they have them, but can work to manage them.

### Inclusive teaching techniques

There are a number of different techniques, such as think–pair–share and plickers, that can be used in the classroom to reduce the raising of hands and shouting-out of answers, which can lead to boys dominating the classroom. These are often discussed in teacher training as best practice, as they increase thinking time, but they should be revisited in the context of increasing participation from girls and quieter members of the class.

**Think–pair–share** Teachers pose a question and give students time to consider it individually. They are then paired up to discuss the topic and share their answers with the rest of the class in turn.

**Plickers** A question–response system based on students each being given a card with a unique visual code, similar to a barcode, that teachers can scan with a mobile phone to get students' answers to their questions. Students are able to answer questions honestly, without fear of judgement from their peers.

### Managing practicals

Assigning job roles that rotate every week ensures that everyone gets the chance to do every role at some point during the term, whether it is setting the equipment up or writing down the results in a table. This removes the gender expectations that may be associated with some roles.

### Gender-aware examples

Many examples commonly used in physics lessons have a male bias, such as talking about angles of reflection in terms of snooker balls hitting the sides of the table, projectiles in terms of missiles, and forces on a ball after a footballer has kicked it. Aiming for more gender-neutral examples – or at least moderating the use of male-biased examples – is intended to widen appeal for all students.

The idea is not that girls aren't interested in football or racing cars, but, when the bulk of the examples used in lessons are typically associated with maleness, this can emphasise the existing connection between physics and maleness in students' minds, and will further deter girls.

Equally, avoid thinking that examples around typically girly things such as hair straighteners will appeal to all girls and won't appeal to boys.

### Lesson observations

By asking a supportive colleague or student to monitor interactions and questions to or from girls and boys, teachers could get a better picture of whether there was a gender divide in their classrooms. We found on average, from around 100 observations, that teachers were asking both genders similar amounts of questions – but boys were shouting out and putting their hand up a lot more.

Having a third party observing lessons can be a powerful eye-opener for teachers. Many of those in participating schools found themselves shocked by the extent to which boys dominate lessons – even if they thought they'd been doing well in terms of gender balance. One project officer reported that one teacher was "horrified" to have realised that girls were such a large proportion of the class but answered so few questions, and that more open-ended questions were directed to boys. Another teacher actively took control of who answered questions in the classroom by dividing it up by gender, with girls at the front and boys at the back. Standing at the front and speaking quietly elicited more responses from the girls, and moving into the middle of the room and continuing discussions from there got the boys offering answers.

> Now we are doing think–pair–share. Before it was boys shouting out – I just thought girls weren't interested.
>
> **Teacher, strand B, 2015**

### Career information

As shown in our 2006 report Girls in the Physics Classroom, girls are more likely to plan ahead with respect to careers, but implementing careers materials into lessons is a longstanding problem for science teachers.

Some teachers simply don't feel confident, particularly if they don't have direct experience of other fields of work. It can also be challenging to fit into schemes of work.

Project officers worked with teachers to trial different ways of talking about careers in the classroom. However, many girls in strand-B schools said that they're still unaware of many careers that need or would benefit from qualifications in physics. Demonstrating the transferable skills that physics develops and which are applicable to a wide variety of careers, as well as the promotion of careers specifically requiring the subject, could be beneficial, but this is an area that needs further exploration.

There should be a clear message that science opens doors to any career, and provides many valuable skills for potential employers. Options aren't restricted to being a scientist or engineer.

### Results

The vast majority of teachers in strand-B schools said that they felt their physics teaching was better, that discourse around the teaching of physics in general and to girls in particular had increased, and that there were changed expectations and mindsets about the subject. They also said that both girls and boys would benefit from the changes in their content and delivery.

The power of the use of data in analysing gender differences and changing delivery was widely noted. Teachers said that there is more interest from girls in physics and STEM in general, and were optimistic about the impact on the A-level physics uptake by girls.

### Lessons learned

There were several sticking points for strand B, including time constraints on teachers, lack of knowledge and capacity to provide careers content, and limited availability of work placements or strong contacts with industry.

A positive staff learning environment and a culture of trust and continuous improvement are both necessary conditions for these interventions to make a difference and to help sustainability. Consistency of staff involvement, particularly of senior staff, is also important to the sustainability of the programme.

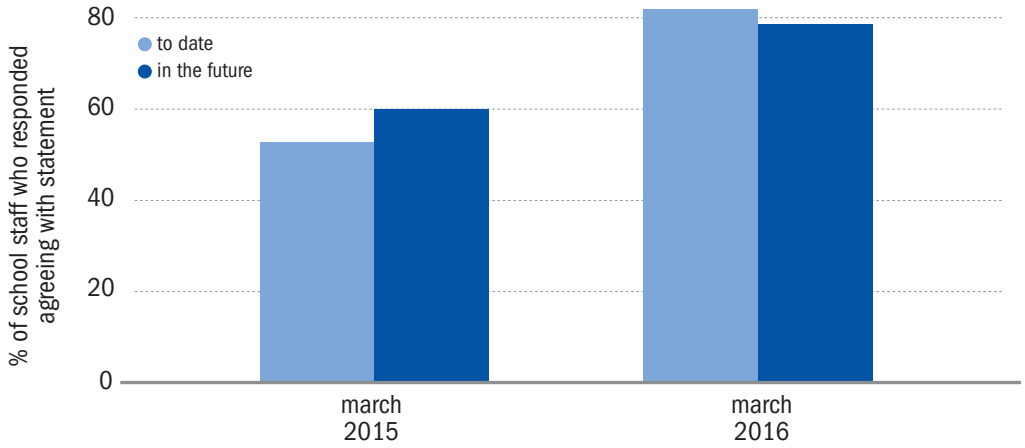
## Main lesson

School staff need to be fully invested for this to work. Unconscious bias awareness-raising and analysis of data were useful tools for engaging staff.

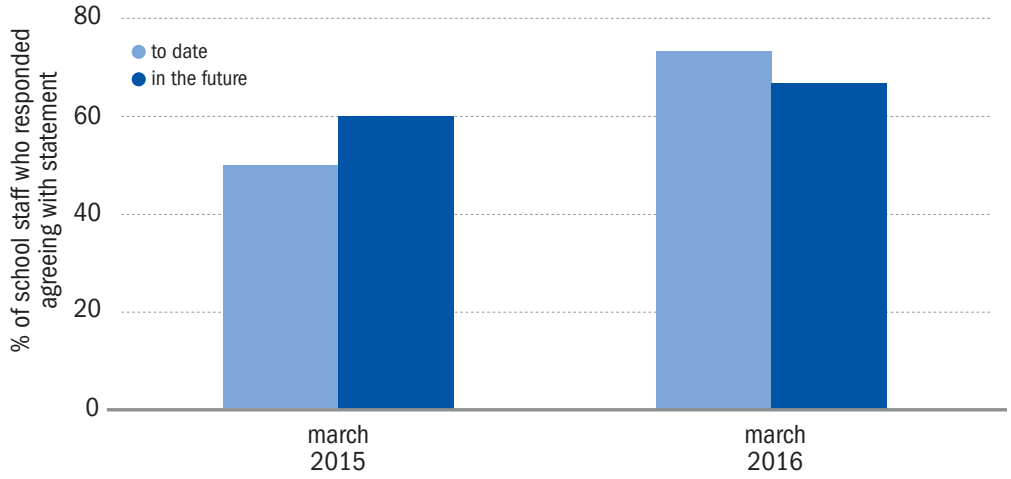
> With careers – the staff we have don't have the knowledge. A big barrier is knowledge.
>
> **Head of science, strand-B school, 2016**

**Strand-B KPIs:** teachers report positive impact on classroom practices.

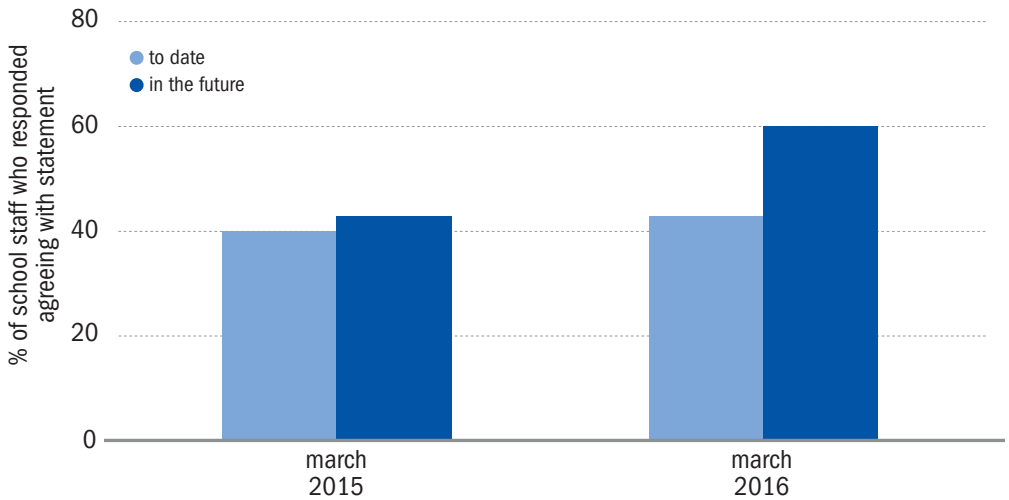
**How effective do you think the IGB programme has been/could be in helping your classroom practice towards girls in physics?**




**...in helping you integrate careers in physics in to your classroom practice?**




**...in helping you integrate careers in physics for girls in to your classroom practice?**



# Strand C: a whole-school approach

Strand C involved working in four schools with senior leaders, governors, students and teachers across all subjects on gender equity and on the culture of the school as a whole.

The IOP's It's Different for Girls report described how the type of school a student attends can affect their likelihood of continuing with physics. And the subsequent Opening Doors project revealed widespread gender stereotyping and unconscious biases.

We can deduce from this that the whole-school environment, and biases and stereotyping, are all factors.

The intention of the strand-C interventions was to develop a culture of gender-awareness across schools in their entirety.

## Activities

### Use of data

By encouraging schools to look at gender balance in A-level classes and comparing figures to the Ofsted publication A-level Subject Take-up, schools can get a picture of how they compare to the national average, and whether there is any trend towards gender imbalance in their school. (It's worth remembering, however, that, for many subjects – including physics – the national average is low and schools' aspirations should be to go beyond this.)

The IOP's 2013 report Closing Doors, which explored gender and subject choice in schools, gives further guidance on how to give an overall gender-balance score to schools. This proved useful in engaging senior leadership teams and raising the priority of the project within the school.

As with strand B above, the use of data can provoke discussion in departmental meetings regarding progression to A-levels and differing gender balance in different streams of streamed subjects.

### Self-auditing tool

A document was developed looking at the school environment, school policy, leadership and staff, school data, what happens in the classroom, and career advice.

Examples of the types of questions it asks include:

- Do displays and notices reflect the diversity of the school and promote positive images of women?

- Is sexual misconduct/gender-specific bullying recognised on the school's reporting system?

It outlines expectations of what good practice is and lets a school measure its progress.

## Why focus on gender stereotypes?

Some schools have observed that girls outperform boys, so, if they were to carry out gender-related projects, they would focus on boys' underachievement. Interventions that reduce stereotypical expectations of behaviour and choice are likely to improve boys' attainment as well as girls' participation. By tackling gender stereotypes and equality across the whole-school culture, boys and girls will both benefit. Meanwhile, the UK has a serious shortage of scientists and engineers. Encouraging girls to choose subjects such as physics leaves their options open to choose a wider range of these jobs in the future.

### School survey

To get a baseline of what teachers thought about issues, an anonymous questionnaire was given to all teachers.

On average, around a third of teachers thought there was an equality policy, a third thought there wasn't and a third said they didn't know. This is a useful tool for assessing the impact of any current equality policy.

### Subject-image survey

Students were asked to give words associated with subjects. These could be used as discussion prompts in a department meeting.

### School action plan

Following an initial audit and planning stage, gender balance across all subjects was written into the school development plan, along with actions to be taken, to ensure the longevity and sustainability of the project.

### Options evening for parents

According to a survey of around 100 year-9 students in one school, the majority (87%) of students had discussed options with an adult at home, compared with 34% who had discussed options with a teacher, highlighting the need to engage with parents.

During the pilot, several different approaches to engaging parents were trialled. Parents enjoyed working on hands-on tasks alongside their children and it proved a useful opportunity to engage parents with messages around where STEM could lead, and also tell them about the stereotyping that sometimes goes with those STEM careers.

### Options evening for students

Students need to be aware of what can influence their decisions, and schools should allow them the space and time for discussion, both with teachers and their peers, in order to allow students to make better-informed decisions.

We would recommend that schools create a focus group of students to review the options process, run a session before options evening for students on how to get the most out of the process, and look at the options information and presentations to ensure they're gender-neutral.

### Unconscious bias training for all teachers

As with strand B above, training on unconscious biases can allow teachers to reflect on what happens in their own school and work to manage any biases they may have. That training should provide an understanding of how the language and images used in a subject can affect a student's perception of whether that subject is for them, and equip teachers to ensure that their classrooms are equitable.

> It's had a profound impact on the way I construct lessons with careful use of pronouns. There is a natural inclination to go to "he" and I'm conscious of the images I use.
>
> **Head of KS5 English, strand-C school, 2016**

> I was keen to get involved with IGB and to work with the programme to discuss the avoidance of gender-stereotypical assumptions with parents through parents evening before options are taken.
>
> **PSHE/careers lead, strand-C school, 2015**

### PSHE/tutor-time activities

A variety of PSHE/tutor-time activities were developed throughout the project, and they pick up a number of themes that the project was aiming to tackle. These include:

- Gender stereotypes
- Employability
- Confidence
- Open and closed mindsets

### One-off activities

Schools organised a variety of one-off events.

One example is a speed-networking event that included female professionals from a range of different backgrounds – the police, the army, construction, finance, physics, and so on. This increased the girls' confidence, changed mindsets and highlighted career possibilities.

Another is the Great Men initiative, which offers a three-hour workshop in which volunteer facilitators work with groups of boys to explore sensitive issues such as sexuality, relationships and domestic violence. Any one-off activities should work with both sexes, as it is not just the attitudes of the girls we need to change.

### Student equality groups

A student-led equality group enables students themselves to explore issues around equality in their school.

In one school, three students from each year group were nominated to be leaders of equality by their peers. They received an induction workshop on the role and responsibilities from their link teacher and were given badges of recognition for their uniform.

The group met fortnightly and undertook different projects as they wished, including:

### Quotes from year-10 students following the Great Men and Great Women workshops

"It made me think... a lot."

"We need more time like this to talk about stuff that is important to us."

"It was thought-provoking. The statistics were mindblowing. And I liked that there were no right or wrong answers."

"The volunteers were really cool and we could talk to them about anything."

"I feel more confident and understand that I'm not alone."

- Debates and discussion relating to equality
- Auditing the school in terms of equality (including recording incidences of good and bad practice in a log book). Findings were shared with staff within the school
- Creating wall displays and posters
- Lobbying the senior leadership to make changes to school policy
- Leading assemblies
- Having equality leaders teach PSHCE lessons on stereotyping

Alternatively, these could be optional extracurricular groups that meet to discuss inequality both inside and outside of school. Either way, students develop a range of transferable skills, such as collaborative working and organisation, and are encouraged to think of ways of combatting difficult issues.

> We might have progress! An assembly run by a male PE teacher about role models featured only male role models. Some girls came out complaining and they were vociferous – they wouldn't have before.
>
> **Head of science and assistant head, strand-C school, 2016**

## Results

A whole-school campaign on gender stereotyping helps students to understand how stereotypes and unconscious bias govern our thinking and behaviour, and empowers them to make choices based on what they want to do, rather than on other people's expectations.

Teachers reported increased awareness of gender stereotypes, although only some students reported the same. More time is needed for the campaign to filter through the school.

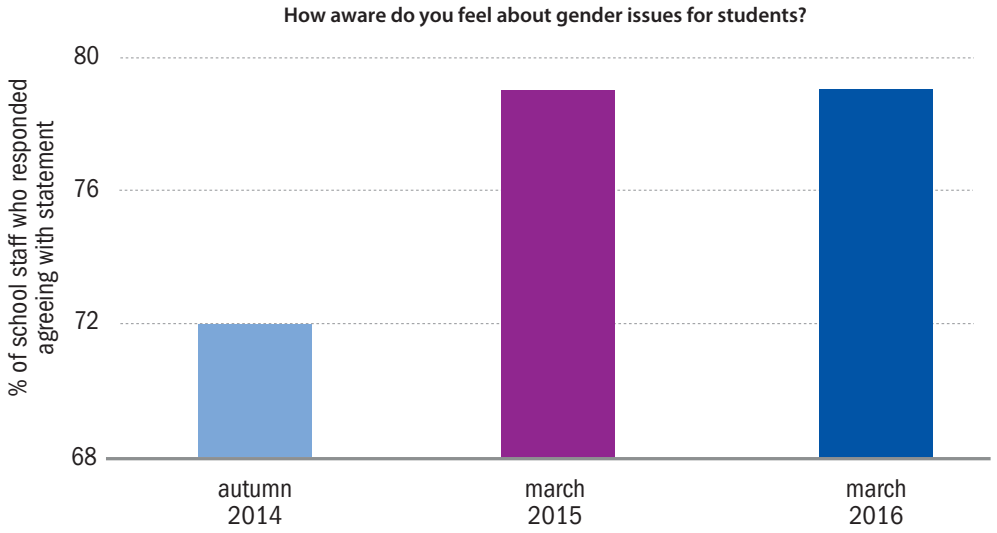
Some strand-C leads and closely involved teachers or school leaders described the programme as "transformational" for their own practice and for starting to turn around entrenched cultures in their schools. Teachers reported changes in the style and content of their teaching, and more self-reflection on their teaching with respect to gender neutrality.

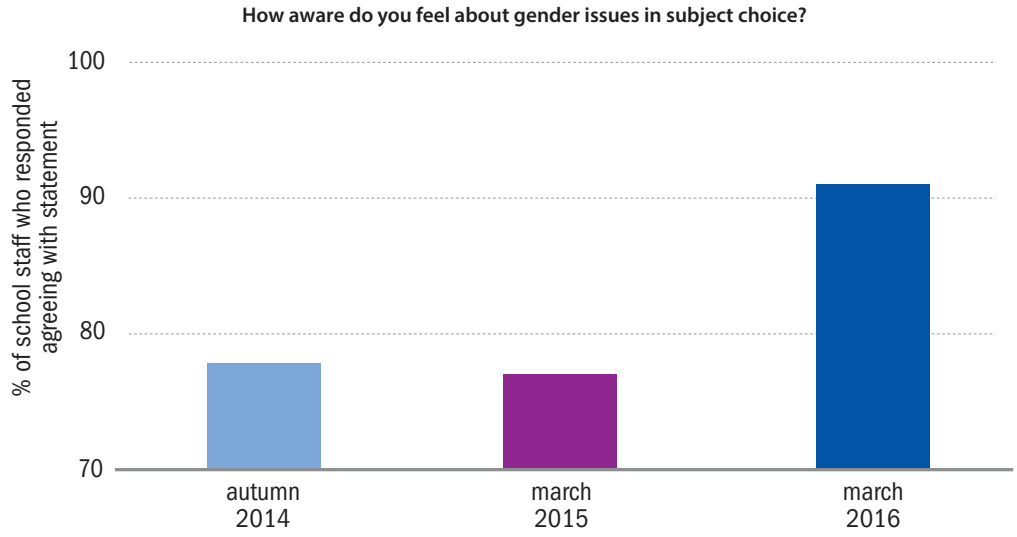
Other impacts include more gender-neutral language among staff and students, and an increase in careers input including an increased awareness of career options that defy gender stereotypes.

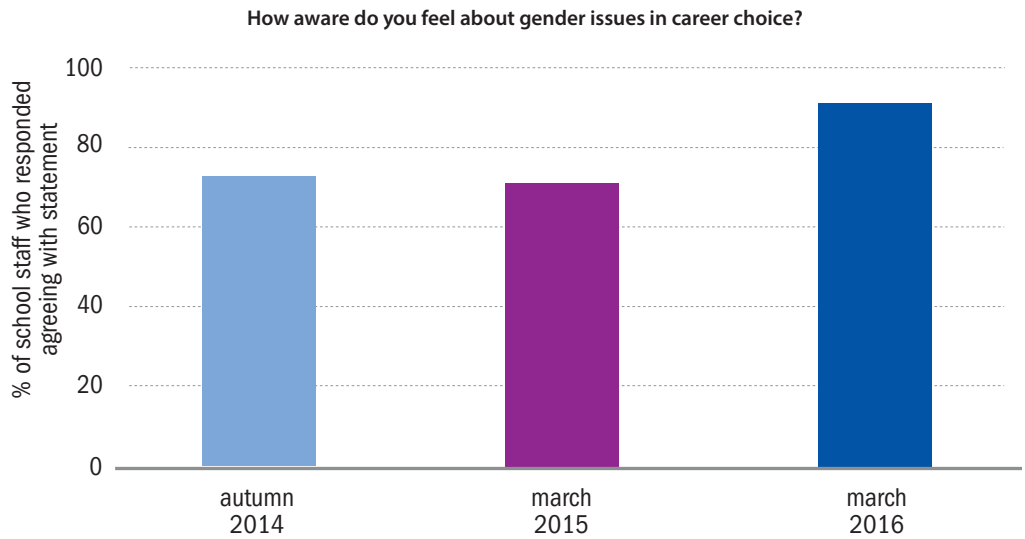
With regards to the impact on female A-level numbers, two schools said that they've had a higher uptake, whereas two had fluctuations – numbers went up and then down again. Staff are optimistic about the long-term effects.

> Legacy? Well it's embedded really well. It will continue. It's permanent. For example, I can honestly say that I will look at data and say: 'Why isn't it the same for males and females?' And find out, then alter things if we need to.
>
> **Assistant head, strand-C school, 2016**

**Strand-C KPI:** teachers report increased awareness of gender-equity issues.



### Lessons learned

These interventions appear to work better when multiple members of staff who work across the whole school were involved in driving the programme forward. An open and trusting environment in which to experiment and to work towards continual improvement is essential.

This requires commitment from all staff to engage and to reinforce the programme across all departments. Particular attention might be given to PE departments, where it seems gender stereotyping, inequality of opportunity – and worse – has been reported by girls in all three strands.

To change culture inevitably takes time – both time to implement the interventions and time for the changes to be felt.

## Main lesson

Strong senior leadership is needed to drive and maintain a culture change in schools.

## Case study: subject choice

Subject choice is at the core of the Improving Gender Balance work in strand C.

Most schools provide a detailed prospectus about the courses that are offered and an options evening for students and their families. We worked with schools to think objectively about the information that they provide and the options process.

In one strand-C school, a student focus group was used to get feedback from sixth-formers about the A-levels options process. The students came from a range of different courses from BTECs to A-level and were from both years 12 and 13.

The main viewpoints shared by the students in the focus group were:

- Options evening is for parents
- The students didn't know what to expect from the options evening
- The students didn't know what questions to ask
- Students didn't consider the content of the courses
- Many students didn't consider the usefulness of the courses to what they wanted to do beyond sixth form

The actions taken based on student feedback were:

- A PSHE lesson was given by tutors outlining what the students should expect from options evening and the questions that they should ask

> I would be interested in what the year 8s are going to do. I would put money on more girls choosing physics.
>
> **Head of KS5 English, strand-C school, 2016**

> There is a raised awareness (of physics). In a recent sixth-form open evening we noticed a big impact with the girls there and I did hear a couple of students who didn't attend talking about it, so there is something going on.
>
> **Head of science faculty, strand-C school, 2016**

- Selected sixth-form helpers attended the PSHE lesson to answer student questions ahead of options evening

- The PSHE lesson gave the students the opportunity to discuss peer pressure and reasons for choosing a course

- The lesson also involved a task in which students were encouraged to challenge societal norms around subject choice

- All sixth formers were given training about unconscious bias and how it can affect subject choice

- A similar PSHE lesson was delivered to students making their KS4 options choices

A simple lunchtime session with sixth-formers was able to inform a range of different actions to tackle specific identified needs. The feedback from the sessions was positive from both year-11 students and sixth-formers.

### Advice regarding options choice

- Review the options information provided to ensure that it is gender neutral and does not reinforce gender stereotypes

- Seek student feedback on the options process

- Ensure that students are prepared for options evening and know what questions are useful to ask

# Drayson Foundation pilot

A pilot funded by the Drayson Foundation took place in six schools in the south east of England, with the aim of increasing uptake of A-level physics among girls and decreasing the numbers of girls and boys making gender-stereotypical subject choices.

The interventions that made up this pilot were designed to be implemented across the whole school, as well as within the physics or science departments.

This pilot combined the different strands from the IGB project activities as described previously in this report, tailoring them to schools' individual needs based on those schools' views of the areas in which most work was needed or what would be most impactful.

Activities such as observations of lessons, professional-development sessions and resources focusing on gender-neutral language, or discussion of and feedback on, gender-aware teaching were carried out across the whole school, rather than solely in science or physics.

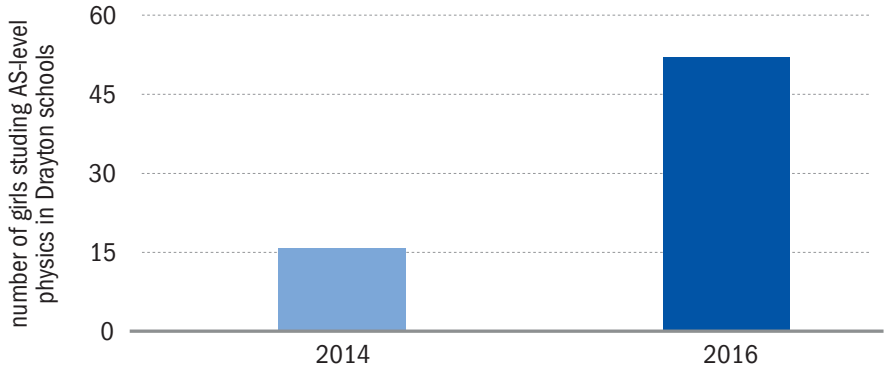
Whole-school INSET days were held for training on unconscious bias and different types of mindsets. Wall displays were reviewed to reduce or eliminate stereotyping in those posters. There were assemblies of year groups, or the whole school, to discuss gender stereotyping. And the project's lead teachers worked with others in the school, particularly careers/PSHE/STEM coordinators to embed Drayson in any other whole-school projects and interventions taking place.

A system of older students mentoring younger ones was also established – both for girls and for boys.

## Results

The number of girls taking AS-level physics in Drayson schools more than trebled over two years, soaring from 16 to 52 students.

**Drayson KPI:** increase A-level physics uptake among girls.




> The promotion of physics in earlier years is having a noticeable effect.
>
> **Head of science/physics, Drayson school, 2016**

> There has been a change [in ethos] especially in science. Even if the teachers don't wholeheartedly agree, they are very aware of their actions, what they do.
>
> **Science teacher, Drayson school, 2016**

Among the project's other impacts, Drayson schools reported increased discourse among themselves on the teaching of physics, and on gender stereotyping and bias, and changes to teachers' own practices. This happened in two stages. First, awareness-raising activities led schools to acknowledge that there was a problem to tackle – training on unconscious bias was most effective at this. Then strategies to overcome gender bias and stereotyping provided alternatives to the mainstream practices that teachers and schools were accustomed to.

In many schools, gender bias and stereotyping can be exacerbated by the language used by teachers and students – often unwittingly – and depictions of men and women in certain careers. Drayson schools reported improvements in teachers' and schools' awareness of the messages given to girls and to boys.

Teachers reported that working in small groups increased girls' confidence, knowledge and skills, but acknowledged that small groups limit the number of girls that this intervention can reach – and that the groups themselves can be self-selecting. Including a mentoring element allowed its effects to spread more widely and made it more scalable.

Participating schools also reported changes in both content and presentation in physics teaching, changes in pedagogy either to girl-friendly or to gender-neutral approaches, and the application of gender-neutral and girl-positive imagery around the school – particularly in relation to careers.

## Case study: research group

CERN@school is a programme that lends small particle detectors to schools and distributes data from detectors in space and in other locations on Earth to schools.

The idea is that students can do real research and make curiosity-driven discoveries, rather than carrying out experiments to which the results are known.

One of the Drayson schools had access to one of these detectors. It was suggested to a number of girls that they take part in this experiment and so they formed RISEUK (Radiation in Soils Experiment). They arranged for soil samples from all over the UK to be sent to their school and tested them for radioactivity. They have then built up a map of the UK showing the radioactivity of soil samples and have presented their work at a number of symposia. This directly increased these girls' confidence in science by giving them first-hand expertise in a particular topic.

The group was student-led, and trained up a new group in the year below as the project progressed. Of the 12 original students, only one initially intended to take any STEM subject at A-level. By the end of the project, 11 of them chose STEM subjects – with three of them continuing with physics. A video about the research project is available at bit.ly/studentscience.

# Barriers

Barriers mentioned throughout the pilot included the following:

- Time limitations – either for the lead contact to engage in interventions, or limitations in lead-in time to properly establish the project across the school
- Depth of engagement from outside science (in cases where the lead contact is based in the science department)
- Existing policies in the school setup, for disciplinary or other reasons, that run contrary to the programme
- The number of whole-school priorities focused on evidenced contributions to raising student results
- The beliefs and personalities of teachers who don't believe that any intervention is necessary
- Psychological barriers in teachers preventing acceptance of the premise of gender bias in school
- The ethos of the school
- Silos in schools – ie, departments or structures in schools preventing a whole-school approach from taking hold
- The comparative strength of parental and societal influences
- Tension for non-science or non-physics teachers between the programme goals and the desire to increase uptake for their own A-level classes
- Limited room for experimentation (restricted to certain classes, not rolled out school-wide)
- Staff turnover, maternity leave, sickness (leading to reduced confidence by girls in their physics teacher and in their own progress)
- Change in lead contact

> The major change is talking explicitly about the problem in school and things like how you present scientists – use female examples. In the physics department the discourse has definitely changed.
>
> **Lead contact, Drayson school, 2016**

> In hindsight, the whole-school perspective... there is pejorative language about science even in [the senior leadership team]. The whole attitude to science is negative. If an example is given about having a problem, it might be 'If you are struggling with your science homework...' – they pick science as an example.
>
> **Lead contact, Drayson school**

## Lessons learned

Although the Drayson pilot was successful on the whole, results in individual schools varied.

The approach taken in the Drayson pilot required input to, and feedback from, staff both within and beyond science/physics. The project initially attracted participants from a range of departments, and in schools where either the programme was more advanced or was working more effectively, efforts had been made to avoid it being seen as a physics or science initiative, sometimes with the lead teacher being in a non-science faculty.

By the time the pilot was being wound down, however, the situation had changed. In schools in which the lead teacher was a member of the senior management team, the programme continued as a whole-school initiative. But in schools in which there had been changes to the lead teacher, a restructure, or where the programme had been rooted in the science or physics department under a lead from that department, it was harder to see real buyin across the school.

In several schools, the pilot failed to engage far beyond the science or physics department. This is largely due to the relatively short scale of the project compared to that of the task, and to a lack of lead-in time to schedule whole-school interventions that increase buyin.

The energy, time and commitment of the lead contact, and their influence at both leadership and cross-school levels, was among the main determiners of the pilot's success.

One major drawback in the pilot was lack of prioritisation or commitment at the school leadership level, and high staff turnover in schools (including new-parent leave, illness and restructuring). An induction to bring new staff fully up to speed on the programme's aims and methods could prove useful.

As seen in strands B and C of the IGB project, work on unconscious gender bias with staff is extremely powerful: it helps convert any staff who are sceptical about gender bias, getting them to recognise the issues and helping to reveal the adverse impacts of gender bias for boys and girls alike.

In the context of the Drayson pilot, early use of unconscious gender-bias training with staff would help raise awareness of the pilot and hopefully increase buy-in and the scope beyond physics or science departments earlier in the programme, leading to wider impact while the impetus is still strong.

There were also pockets of resistance to the very idea of gender imbalance, creating a barrier that needs to be overcome at the start for a project such as this to function properly.

Ultimately, for a programme such as this to be effective, the schools' senior staff must be involved, whole school must really mean the whole school, and interventions should be higher intensity and longer lasting.

### Main lesson

A combined approach requires buyin and commitment from senior leaders, adequate time and resources, and systems that enable the project to happen.

# Conclusion and recommendations

The IGB and Drayson projects provided further evidence that schools can heighten societal stereotypes, that this can have an effect on subject choice and that targeted interventions can successfully redress this.

All three strands of the IGB project had positive outcomes. The Drayson schools, in which the various strands were combined, saw a drastic increase in numbers of girls taking AS-level physics.

We recommend that any future implementation has elements from all three strands incorporated into the approach – building confidence, inclusive teaching and involving the whole school.

In general, strands B and C are more difficult to implement if the school as a whole is not open to change. For strand C, good communications and a structured working group also seem necessary.

Strand-B activities may be used to start to engage the rest of the school, as well as to realise the early benefits of changed physics teaching. Practices to ensure lessons are gender-neutral or girl-friendly – which are beneficial both to girls and to boys – will be useful.

At the same time, full engagement from the senior leadership team for a long-term programme of cultural change in a school can begin based on the strand-C approach. Quick wins will help the long-term strategy of combatting entrenched areas of gender stereotyping.

To help a combined approach, groups of schools should work in partnership – including with satellite primaries. In those primaries, a guided learning process is also recommended but with physics clearly labelled in order that pupils know what its study includes.

Further recommendations on measures to redress gender imbalances are set out below.

## Recommendations

To make a significant difference to students' perceptions, work needs to be done across the whole school to challenge gender stereotypes. Good practice in the science department with regards to encouraging under-represented groups may be negated if gender lines are then enforced in other subjects, in break times, or in extracurricular activities.

### Appoint a gender champion

For any issue to be taken seriously by a school, someone in the senior leadership team needs to be given responsibility for outlining and implementing a plan, and for encouraging the take-up by staff throughout the school.

### Use data and evidence

By comparing the progression in traditionally gendered subjects to the national average, schools can get an idea of how their schools compare to the national average in terms of gender equality in subject choice. This can help identify areas for concern and provide incentives for action. Also look at where else there is a gendered pattern.  What is the gender split in the top, middle and bottom classes?

### Train teachers

Teachers, like everyone, have unconscious biases, which can affect the experience of different groups in the classroom – what is said to students, feedback on their work, expectations of them and career suggestions. This training is advantageous in different ways for teachers of physics and for staff across the whole school.

Training can raise awareness of unconscious bias and its potential impact in the classroom, allowing teachers to reflect on their practice and adjust to ensure the best experience for all students. This is of particular importance to physics teachers – by adapting their teaching practices to be more inclusive they can have a big impact on uptake of physics by girls.

Teachers also need training on how to deal with sexist and sexual comments or inappropriate behaviour.

### Rethink science clubs

Science clubs are often quite boy-heavy, which can put off interested girls. This can be tackled by inviting girls who might not otherwise consider taking part. Research projects such as Cern@school and Crest awards attract a better gender balance, as do science ambassador schemes – in which students do outreach with primary schools.

### Options guidance

Create a focus group of students to review the options process, run a PSHCE session before options evening for students on how to get the most out of the process, and look at the options information and presentations through a gender lens.

### Increase students' awareness and engagement

Ask students to challenge their biases and the biases of others around them. Engage them in the issues and encourage them to think of ways to combat them.

## Next steps for the IOP

We won't be able to further improve the number of girls taking A-level physics unless more is done to change school culture. Schools need to become the fertile ground in which the seeds of girls' engagement with physics can grow. We'll continue to work with schools in England through the Stimulating Physics Network, to support them both to improve their physics teaching and to create a more inclusive environment for both genders using the lessons learned from the projects covered in this report. We're also working with authorities in Scotland and Ireland on these issues.

We will continue to support the improvement of physics teaching throughout all of our work. We've started to reach beyond physics and, while we're happy that our work is having an impact, we alone cannot provide the solution. We need gender equality in schools to be considered at every level and, for that, organisations need to commit to it. We need school and subject organisations to think about what else they could be bringing to the table. Working in isolation on problems such as boys' underachievement is not going to lead to solutions unless the bigger picture, like the environment in which boys thinks it's girly to work hard, is taken into account. We're working with partners to develop a gender-equality mark and a framework to help schools tackle the overarching problem of inequalities in the school system, rather than merely treating the symptoms that show up as gendered behaviour.

# Appendix: sources and further reading

## Institute of Physics publications and resources

All IOP publications are available online at **iop.org/publications**.

- Girls in the Physics Classroom: A Review of the research on the participation of girls in physics (2006)
- Girls in the Physics Classroom: A teachers' guide for action (2006)
- Girls into Physics: Action research (2009)
- It's Different for Girls: The influence of schools (2012)
- Closing Doors: Exploring gender and subject choice in schools (2013)
- Opening Doors: A guide to good practice in countering gender stereotyping in schools (2015)

Classroom resources are available at **iop.org/genderbalance**.

## Project evaluations

Evaluation of the Improving Gender Balance Programme: Final qualitative report, James Lambley & Associates, 2016

Evaluation of the Drayson Girls in Physics Pilot Programme: Final report (qualitative phase), James Lambley & Associates, 2017

## ASPIRES

The report from King's College London's ASPIRES project, ASPIRES: Young people's science and career aspirations, age 10–14 (2013), is available on the university's website at **kcl.ac.uk/sspp/departments/education/research/ASPIRES/Index.aspx**.

## Academic research on mindsets and on confidence and resilience

Aronson & Inzlicht, Improving adolescents' standardized test performance: An intervention to reduce the effects of stereotype threat, Journal of Applied Developmental Psychology (2003)

Blackwell, Trzesniewski & Dweck, Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention, Child Development (2007)

Dweck CS, Motivational processes affecting learning, American Psychologist (1986)

Murphy P, Are gender differences in achievement avoidable? Issues in Science Teaching (2000)

## Implicit bias test

One such test is available online via the Harvard University website at **implicit.harvard.edu/implicit/takeatest.html**.

**For further information contact:**
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**IOP** Institute of Physics
76 Portland Place, London W1B 1NT
Tel +44 (0)20 7470 4800
Email education@iop.org
**www.iop.org/genderbalance**

Registered charity number 293851 (England & Wales) and
SC040092 (Scotland)

This guide is available to download from our website and if you require an alternative format please contact us to discuss your requirements.

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The Kitemark is a symbol of certification by BSI and has been awarded to the Institute of Physics for exceptional practice in environmental management systems.

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