## It's Different for Girls The influence of schools

An exploration of data from the National Pupil Database looking at progression


## Acknowledgements

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## FOREWORD



In 2011, physics was the fourth most popular subject for A-level among boys in English schools but for girls the subject languished in 19th place. This new report from the Institute of Physics shows that many girls across the country are not receiving what they're entitled to - an inspiring education in physics. In turn this has led to the poor representation of girls in physics, denying them individual opportunities and contributing to the UK's shortage in STEM skills.

This is an issue that the Institute has been working on for some time. Our review of the research around the participation of girls in physics is widely quoted and we have promoted an "action-research model" and produced resources to support physics teachers who want to encourage more of their female pupils to engage with the subject.

There have been individual successes but these have been sustained only in schools where the interventions have been part of a long-term programme that extends beyond the individual teacher, includes the whole school, and perhaps even ventures into the home.

Other research has shown that perceptions of physics are formed well beyond the physics classroom: the English teacher who looks askance at the girl who takes an interest in physics or the lack of female physicists on television, for example, can play a part in forming girls' perception of the subject. We need to ensure that we are not unfairly prejudicing girls against a subject that they could hugely benefit from engaging with.

This report takes a snapshot of the situation, using A-level data from 2011 to assess the choices that girls in English schools are making, and shows startling differences between different kinds of schools, suggesting that many girls in the state sector are being deprived of significant opportunities.

We hope that this report brings the issue to the attention of school leaders, policymakers, and parents, and that it will be a stimulus for real change. Physics should be represented in schools to boys and girls alike as an exciting, relevant and deeply enriching subject that will open up new opportunities throughout their careers.

Professor Sir Peter Knight
President, Institute of Physics

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## INTRODUCTION

# The low numbers of girls choosing to take A-level physics is a continuing cause for concern. It means that girls who would enjoy and excel at $A$-level physics are being denied the opportunity because their experience of physics up to age 16 is not as encouraging or positive as it should be. 

Girls and boys do equally well at GCSE-level physics and science/additional science (previously double-award science). However, the percentage of A-level physics students who are girls has stayed at around $20 \%$ for the past 20 years or more.

To address this problem, the Institute commissioned two pieces of research in 2004. The Review of the Research into the Participation of Girls in Physics (Murphy and Whitelegg 2006) aimed to consolidate current understanding of the problem and to identify reasons from existing research into why girls choose not to continue studying physics post-16. In addition, A Teacher's Guide to Action (Hollins et al. 2006) included evidence from a study of schools that were particularly successful at encouraging girls to continue with physics post-16.

The main influences on students' attitudes to physics were found to be:

- self-concept - that is students' sense of themselves in relation to the subject;
- how students experience physics at school;
- teacher-student relationships - that is, how personally supportive students find their physics teacher.

The Institute, in partnership with the National Network of Science Learning Centres, worked on action-research projects with a number of very engaged teachers and their classes. However, evidence from the report Two years on: A review of the Girls into Physics action-research projects (Laura Grant et al. 2011, unpublished) showed that success is difficult to sustain unless the interventions go beyond the individual teachers and become part of a department or school-wide programme.

In this report we have taken a different approach. Using data from the National Pupil Database, which tracks pupils as they go through school, we have looked for differences in the patterns of choice of A-level physics for girls and boys in different types of schools. We have used data on pupils doing A-levels in England in 2011 tracked back to the school where the pupils were taught for their GCSEs in 2009.

Questions 1 and 2 look at data on all schools; questions 3 to 6 look at data on maintained schools only. "Maintained schools" refers to all types of state-funded schools, including academies, and "independent schools" are all fee-paying schools. Schools that sent
small numbers of pupils on to take A-levels are included in the analysis because this includes a significant number of schools and pupils who went on to take physics A-level. For more on this, see the appendix.

There are obvious, and well known, differences between the progression rates from, for example, single-sex schools compared with co-ed schools and there are many factors that influence the differences in behaviour, such as access to specialist teachers, selection at age 11 and socioeconomic background. However, averaged over the large samples of schools, these influences should have the same effect for both boys and girls, but the differences in patterns of behaviour are not the same - they are nearly always more marked for girls. The variation in the experience of physics between school types is not gender-neutral: it's different for girls.

Therefore, we suggest that there are other, gender-specific cultural influences coming into play. Teaching and learning are culturally embedded experiences and the way that the subject of physics appears to girls in, for example, the co-ed setting seems to be very different from that of the single-sex setting. It would appear that, in many schools, expectations of students are often gender stereotyped. This must be challenged by a school-wide approach to gender equity, with support from government, if it is to be addressed successfully.

Girls are actively encouraged into physics and the school has a very upbeat science faculty. The key messages for encouraging girls into physics are to make physics accessible, build the girls' confidence and make physics engaging.
Head of physics, non-selective girls' school

## MAIN FINDINGS

## Q1

 49\% of maintained co-ed schools sent no girls on to take A-level physics in 2011. The figure for all secondary schools is $46 \%$.
## Q2

 Girls were almost two and a half times more likely to go on to do A-level physics if they came from a girls' school rather than a co-ed school (for all types of maintained schools in England).
## Q3

Twice the percentage of girls who went on to do A-level physics came from schools with a sixth form, compared to schools that only teach up to age 16 (for co-ed maintained schools in England).

Q4
For maintained schools in England, the positive effect of single-sex education on girls' choice of physics post-16 is not replicated in the other sciences.

## RECOMMENDATIONS

20\%
of physics
A-level students were girls in 2011

## challenge

 gender stereotyping
## To government and its agencies

- The large number of schools that send no girls on to study physics at A-level is unacceptable. Co-ed schools should have a target to exceed the current national average of $20 \%$ of physics A-level students being girls.
- Gender equity needs to be part of the Ofsted inspection criteria, so that a school cannot be judged outstanding if there are clear participation issues that are not actively being addressed.
- Research by the Institute of Physics (Murphy and Whitelegg 2006) and others shows that girls often have different learning patterns from boys, and trainee teachers need to be made aware of these differences, so that they can engage the same level of interest from both boys and girls in their classes.


## To head teachers

- Gender equity and access to all subjects is an issue that should be actively considered in all schools. Schools should meet targets for the numbers and gender balance recruited to physics A-level. Targets should be set to exceed national figures given in this report for each type of school.
- Gender stereotyping by both teachers and pupils needs to be actively challenged both in and out of lessons and across all subjects (see The gender equality duty and schools - guidance for public authorities in England EOC 2007). In science, the attitude that "physics is for boys" should be discouraged among students and teachers.
- Common misconceptions about girls' abilities in the subject are challenged by academic results and these must be recognised. Equally, differences between girls and boys, and the teaching styles that suit each should be recognised and followed. (These are discussed in the resources given at the end of this report.)

In terms of best practice, it comes down to the attitude of the kids, and the staff available. The hard thing is developing a trend - once a culture is established, the pattern of more girls in physics A-level seems to continue. Head of physics, non-selective 11-18 co-ed school


## To parents

- There are clear differences between schools, with some being much more successful at sending more girls on to study physics A-level. Research carried out by the Institute of Physics suggests that differences in teaching and in school culture significantly determine whether students will continue their physics education. Parents' attitudes to science and their knowledge of its associated benefits are also known to contribute to students' progression.
- When choosing a secondary school for your daughter or son, ask about the number of girls studying A-level physics, as this will be a good indicator of the quality of physics teaching within the school.
- Help your daughter or son to understand gender stereotypes and how they are perpetuated and used in the media, so that they can be explicitly challenged.
- Ask your daughter or son's school for careers information and work experience that challenge gender stereotypes and provide insight into all the science, technology, engineering and mathematics (STEM) career pathways.

From the girls' point of view, their attitude to physics is very positive. It is not seen as a boys' subject, or as something they cannot do. We know about national trends of fewer girls going into physics, but rather than encouraging girls specifically, we are trying to do our best for every student, and we know we are doing pretty well.
Head of physics, non-selective 11-18 co-ed school

The lack of any pressure between boys and girls to behave stereotypically seems to filter into physics teaching, where boys and girls respond equally well to practical work and teaching that contextualises physics concepts in historical terms or contemporary uses.

## Head of physics, selective co-ed

 grammar school

## HOW DOES NATIONAL TAKE-UP OF PHYSICS A-LEVEL DIFFER BETWEEN GIRLS AND BOYS?


girls took physics A-level in 2011

## Summary

The take-up of physics is clearly very different for boys and girls in England. Of particular concern is the large number of schools that sent no girls on to do A-level physics (four times more than for boys). It may be that the problem is going unnoticed. It should become a priority and be registered as an issue within schools.

## Data

We know that 6159 girls took physics A-level in 2011 (source: Joint Council for Qualifications) and that physics was the 19th most popular choice for girls (as opposed to fourth for boys). But what are the numbers in individual schools, and how do they compare with numbers for boys?

Figure 1a is a frequency chart for schools with girls or boys sending 0-6 girls or boys on to A-level physics. There were 3510 schools with girls and 3316 schools with boys.

## Commentary

- $1603(46 \%)$ of all schools with girls sent no girls on to complete A-level physics in 2011. The equivalent percentage is only $14 \%$ for all schools with boys.
- A similar graph for maintained schools shows that 49\% of co-ed schools sent no girls on to take A-level physics.
- The distribution for girls drops off very quickly. Almost $70 \%$ of schools sent zero or one girl and $80 \%$ sent zero, one or two girls on to take physics A-level.

Figure 1a: Number of schools against the numbers of girls and boys progressing to A-level physics in 2011


## Data

Percentages serve as a more reliable relative measure than absolute numbers and take into account school size and the number of pupils sent on to take A-levels.

Figure 1b shows the numbers of schools that sent certain percentages of girls and boys on to
take A-level physics in 2011 out of those girls and boys who went on to take A-levels.

## Commentary

- 68\% of schools with girls sent on a percentage of girls smaller than $2.5 \%$, compared with just $19 \%$ of schools with boys.

Figure 1b: Number of schools against percentages of girls and boys progressing to physics A-level in 2011


Science is strong at the school, and physics has its own identity within the sciences. Boys and girls get along very well; they don't feel peer pressure within the school to behave like boys and girls. People can be individuals.
Head of physics, selective co-ed grammar school

## Data

69\% of all schools are maintained co-ed schools (2605). When we consider the numbers of girls and boys that went on to take physics $A$-level from these schools alone, there is an even greater percentage of schools that sent no girls on to take physics A-level.
Figure $\mathbf{1 c}$ shows the number of maintained co-ed schools that sent certain percentages of girls and boys on to take A-level physics of those girls and boys who went on to take A-levels in 2011.

## Commentary

- 1281 (49\%) of maintained co-ed schools sent no girls on to take A-level physics in 2011, but only $12 \%$ of schools sent on no boys.
- Only $26 \%$ of maintained co-ed schools sent on a percentage of girls greater than $2.5 \%$, while $84 \%$ of these schools sent a percentage of boys greater than $2.5 \%$.
- The modal range for girls is $0-2.5 \%$. For boys it is $5.5-8.5 \%$.

Figure 1c: Numbers of maintained co-ed schools against percentages of girls and boys progressing to physics A-level in 2011


When it comes to good teaching, one must look at the children you are going to teach and know what will appeal. This means knowing your students and understanding why they are studying physics.
Head of physics, non-selective girls' school


## IS PROGRESSION INTO PHYSICS A-LEVEL DIFFERENT FOR INDEPENDENT/MAINTAINED SCHOOLS AND CO-ED/SINGLE-SEX SCHOOLS?

## Summary

Although many factors (prior attainment, socioeconomic factors, etc) come into play, the effects are more marked for girls than boys, so it is likely that there is a real issue for girls in the maintained co-ed sector.

## Data

Figure 2 shows the percentages of girls and boys who went on to take physics A-level out of those girls and boys that went on to take A-levels in 2011 from independent schools and maintained schools, sub-divided into single-sex and co-ed schools.

## Commentary

- We already know that independent schools get a higher percentage of their students to take A-level physics. However, the effect is more marked for girls in both single-sex and co-ed schools.
- Independent girls' schools sent four times more girls on to do A-level physics than maintained co-ed schools, compared with only twice (1.9 times) the percentage for boys.
- In the maintained sector, single-sex schools send on 2.4 times more girls and 1.5 times more boys to study A-level physics than co-ed schools do. In independent schools, the percentage of boys is almost the same whether they are in the single-sex or co-ed setting.

Figure 2: Percentages of girls and boys who went on to take physics A-level in 2011 by type of school


## IS PROGRESSION DIFFERENT FOR DIFFERENT TYPES OF MAINTAINED SCHOOL - WITH AND WITHOUT SIXTH FORMS?

## Summary

Students are less likely to progress to physics A-level from schools that end at Key Stage 4. This effect is more marked for girls and is more marked still in single-sex schools. We acknowledge, however, that single-sex schools with sixth forms are likely to be selective grammar schools.

## Data

Figure 3 shows the percentage of girls and boys who went on to take A-level physics out of girls and boys who went on to take A-levels in 2011 from maintained schools, broken down by whether their GCSE school had a sixth form or not.
Schools without sixth forms that take pupils to the end of Key Stage 4 only are called "to 16" and schools with sixth forms that continue to Key Stage 5 are called "to 18".

There are fewer than 10 independent schools that offer GCSEs only, and therefore the results for independent schools are not given.

## Commentary

- Almost twice (1.9 times) the percentage of girls progress to physics A-level from maintained co-ed schools that continue to 18 , compared with girls from schools that end at 16 . The ratio for boys is less.
- In maintained single-sex schools the ratio for girls and boys between schools that continue to 18 and those that end at 16 is even greater. For both girls and boys, almost three times the percentage progress between schools with sixth forms and those without.
- The ratio between girls and boys from maintained co-ed schools is worse than the equivalent for single-sex schools.

Figure 3: Percentages of girls and boys who went on to take physics A-level in 2011 from maintained schools with and without sixth forms


## IS THE PATTERN FOR PHYSICS DIFFERENT FROM OTHER SCIENCE SUBJECTS?

## Summary

Although physics is less popular than the other sciences with girls generally, the subject appears to be perceived differently in co-ed schools compared with single-sex schools. There is something about doing physics as a girl in a mixed setting that is particularly off-putting, in comparison with the other sciences.

## Data

Figure 4 shows the percentages of girls and boys who took each science A-level in 2011 of the total number of girls and boys who went on to take A-levels in 2011, against a breakdown of the school type where they sat their GCSEs.

## Commentary

- The percentages of girls going on to take science A-levels show a marked preference for biology, with chemistry second and physics third by a long way. By contrast, for boys, the percentages choosing the three sciences vary very little across the subjects, whether in co-ed or single-sex schools.
- More students progress to all of the science A-levels from single-sex schools than from co-ed schools. However, for girls and physics, the difference between co-ed and single-sex schools is more marked; single-sex schools send on 2.4 times more girls to study A-level physics than co-ed schools do.
$\qquad$
Figure 4: Percentages of girls and boys who went on to take science A-levels in 2011 from maintained co-ed and single-sex schools



## DOES THE ACADEMIC ACHIEVEMENT OF THE SCHOOL AFFECT THE PERCENTAGE OF GIRLS GOING ON TO A-LEVEL PHYSICS?

## Summary

Both girls and boys tend to take up physics A-level in higher percentages when the school where they sat their GCSEs has higher GCSE attainment. However, the effect of a school's GCSE achievement on choosing A-level physics is, once again, greater for girls.

## Data

Figure 5a shows the percentages of girls and boys who went on to take physics A-level out of girls and boys who went on to take A-levels from maintained co-ed schools in 2011 against that school's GCSE achievement, given by the percentage of pupils who achieved five or more A*-C grades in their GCSEs in 2010.

## Commentary

- In maintained co-ed schools, the percentage of students going on to take physics A-level increases with the academic achievement of the school. But it increases more for girls than for boys.
- Girls are more than twice as likely (2.2 times) to take A-level physics when coming from a school in the highest band compared with a school in the lowest band. The difference in the percentage of boys is less marked. Boys are just over one and half times (1.7 times) more likely to take A-level physics when coming from a school in the highest band compared with a school in the lowest band.

Figure 5a: Percentages of girls and boys who went on to take physics A-level from maintained co-ed schools in 2011 against school GCSE achievement in 2010


## Data

Figure 5b shows the percentages of girls and boys who went on to take physics A-level out of girls and boys who went on to take A-levels from maintained single-sex schools in 2011 against that school's GCSE achievement, measured by the percentage of pupils who achieved five or more $\mathrm{A}^{*}-\mathrm{C}$ grades in their GCSEs in 2010.

Fewer than 10 maintained single-sex schools had $51-60 \%$ of pupils achieve five or more $A^{*}-C$ GCSE grades in 2010, so results for this band are not given.

## Commentary

- The picture in maintained single-sex schools is somewhat different, with the percentage of boys going on to A-level physics actually being less than from co-ed schools for some bands of GCSE achievement. However, for girls, the percentage going on to do A-level physics is greater for single-sex schools in every band of GCSE achievement.
- For maintained single-sex schools in the top band of GCSE achievement, which are likely to be selective grammar schools, girls are more than two and a half times (2.6 times) more likely to go on to do A-level physics than those from a co-ed school in the same band of GCSE achievement. The figure for boys is only just over one and a half times (1.6 times).

Figure 5b: Percentages of girls and boys who went on to take physics A-level from maintained single-sex schools in 2011 against school GCSE achievement in 2010


$\square$We adopt a traditional approach to A-level and teach concepts so the girls develop a deeper understanding - and the girls love it. Physics is taught for the purity of the subject, but you have to teach it well. At A-level, GCSE and throughout KS3, girls are taught by physics specialists, and this is vital to developing an interest in physics.
Head of physics, selective girls' grammar school

## DOES THE SOCIO-ECONOMIC BACKGROUND OF THE SCHOOL HAVE AN IMPACT ON PROGRESSION?

## Summary

The socioeconomic background of the school has a strong effect on the percentage of girls and boys going on to take physics A-level, with schools with higher proportions of free school meals (FSMs) sending on lower percentages of both girls and boys.

## Data

A FSM, provided to a student during a school break, is paid for by government. For a child to qualify for a FSM, their parent or carer must be receiving specific qualifying benefits. The number of FSMs per pupil is therefore a socioeconomic indicator for the school.

Figure 6 shows the percentage of girls and boys who took physics A-level out of those girls and boys who went on to take A-levels in 2011 from the maintained schools where they sat their GCSEs (these are not all maintained schools, but a representation), against the number of FSMs per pupil at those schools in 2010.

## Commentary

- Although the percentage of girls is always less than that of boys, the socioeconomic background of the school does not appear to affect girls' choice of physics any more than it affects that of boys.

Figure 6: Percentages of girls and boys who went on to take physics A-level in 2011 from maintained schools against the number of FSMs per pupil at those schools


## APPENDIX

Figure 7 gives the distribution of girls and boys who went on to take physics A-level in 2011 sorted by the number of pupils who went on to take A-levels from the school where they sat their GCSEs.

We investigated the effect of excluding schools that sent on 60 or fewer pupils to take A-levels from the analysis of this report, and discovered that it had very little effect on the figures. There
are 863 secondary schools that sent 60 or fewer pupils on to take A-levels in 2011; 516 of these are independent schools and 347 are maintained.
From these 863 secondary schools, 397 girls went on to take A-level physics, which is $2.7 \%$ of girls who went on to take any A-levels from these schools.

Figure 7: Distribution of girls and boys who went on to take physics A-level in 2011 across the number of pupils that went on to take A-levels from the school where they sat their GCSEs


$\square$Girls love practical work. They engage with everyday examples, but it depends on the context because topics such as cars might switch them off. The teacher should let them construct the relationship with the topic, themselves, from practical work.
Head of physics, non-selective girls' school

## REFERENCES AND FURTHER RESOURCES

Further resources with advice on how to achieve gender-inclusive teaching in physics are available from the Institute of Physics. How they can engage girls better through active classroom management, contextualised teaching and careers information, for example.

## Institute of Physics "red book" series

- Murphy and Whitelegg 2006 Girls in the Physics Classroom: A review of the research on the participation of girls in physics
- Hollins et al. 2006 Girls in the Physics Classroom: A teacher's guide for action
- Engaging with Girls: increasing the participation of girls in physics - an action pack for teachers 2010 This includes: Grant, Bultitude and Daly 2010 Girls into Physics: Action Research - a practical guide to developing and embedding good classroom practice.

For all of these, see the IOP Girls in Physics webpages at www.iop.org/girlsinphysics.

## Department for Education publications

- Girls into Physics: Action Research 2009 Research Brief DSCF-RB103 - to download go to www.education.gov.uk/publications/standard/publicationDetail/Page1/DCSF-RB103
- Girls into Physics: Action Research 2009 Full Research Report DCSF-RR103 - to download go to www.education.gov.uk/publications/standard/publicationDetail/Page1/DCSF-RR103

Girls' career aspirations, OFSTED, 2011
www.ofsted.gov.uk/resources/girls-career-aspirations
The gender equality duty and schools:guidance for public authorities in England, EOC, 2007
www.epm.co.uk/schools/Gender_Equality_Duty_and_Schools_Guidance.pdf

## ESRC Targeted Initiative on Science and Mathematics Education (TISME)

http://tisme-scienceandmaths.org/
Through a portfolio of research studies and dissemination activities, TISME aims to find new ways to encourage children and young people to greater participation, engagement, achievement and understanding of science and mathematics.
The partner projects include:

- Understanding Participation rates in post-16 Mathematics and Physics (UPMAP) www.ioe.ac.uk/study/departments/cpat/4814.html
- Strand 3 analysed interviews with first-year undergraduates about their subject choices www.ioe.ac.uk/BERA2011RoddReissMujtabaUPMAPpost18physicsS_2.pdf
- Science Aspirations and Career Choice: Age 10-14 (ASPIRES)
www.kcl.ac.uk/sspp/departments/education/research/aspires/index.aspx
For more information see Archer L, Osborne J \& DeWitt J 2012 Ten Science Facts \& Fictions: The Case for Early Education about STEM Careers London: The Science Council


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