Stimulating Physics Network: Phase 4 and Phase 5 evaluation

Report from FFT Education Datalab to the Institute of Physics

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1 Executive summary

1.1 Methodology

- This report evaluates the effect of taking part in the Institute of Physics' *Stimulating Physics Network* project (SPN).
- SPN has been running since 2009 in phases lasting between 2 and 3 years; this evaluation looks at the impact of taking part in Phase 4 (2014-16) and Phase 5 (2016-19).
- Our analysis used data from the National Pupil Database (NPD) to compare the performance of pupils in schools that took part in the project to the performance of pupils in other schools. This was done in three ways:
  a) Comparison of the change in number of entries to A-level physics in SPN schools and all other schools, relative to a baseline year (2015 for Phase 4, 2017 for Phase 5)
  b) Simple comparison of change in attainment in GCSE physics, number of entries to A-level physics from various groups of students, and A-level grades in SPN schools and a matched comparison group, relative to a baseline year (2015 for Phase 4, 2017 for Phase 5)
  c) A more detailed comparison of attainment at GCSE physics, the likelihood of pupils progressing to complete an A-level in physics, both overall and for female pupils, and A-level grade in SPN schools. This was achieved by matching participating schools to a statistically similar comparison group of non-participants, using multilevel regression models adjusted to take account of pupil-level characteristics and bootstrapping to account for uncertainty in the matching process, and looking at how impact varied by dosage (where available); that is, by how much a school engaged with the project.
- For Phase 4, we consider the impact on these outcome measures in each year from 2014-19, and for Phase 5, in each year from 2016-19. As the SPN project predominantly works with schools at Key Stages 3 and 4, we would not expect the impact on A-level physics exam entries to be seen until at least two years after the intervention, when KS4 pupils have progressed to A-level. Students who were in Year 10 at the start of the intervention would sit A-level four years later (2018 and 2020 respectively for Phases 4 and 5).
- Analysis a) used all 355 schools that took part in Phase 4 and all 726 schools that took part in Phase 5 as partner schools, while analyses b) and c) used a reduced dataset, consisting of the 286 Phase 4 schools and 268 Phase 5 schools that had not taken part in any earlier phases of the project.
- The comparison group used in analyses b) and c) was created by matching SPN schools to similar schools based on various criteria, including characteristics such as region, pupil demographic characteristics, historical achievement in physics and progression rates to A-level physics.

1.2 Main findings

We present the main findings from each of the three analyses:

Analysis a): Change in entries to A-level physics relative to baseline

- We found an increase in A-level physics entries from Phase 4 schools that, after three years, was almost six percentage points above the national increase (17.4% compared with 11.6%).
- We found an increase in A-level physics entries from Phase 5 schools that, after two years, was slightly below the national increase.
- In 2018, A-level physics entries from students in Phase 4 schools were 17.4% higher than in the 2015 baseline year, compared to 11.6% higher in all other schools. In 2019, entries from

students in Phase 5 schools were 7.8% higher than the 2017 baseline year, compared to 9.6% in all other schools.

- We found a relative increase in A-level physics entries from female students in both Phase 4 and Phase 5 schools.
- In 2018, entries from female students in Phase 4 schools were 29.2% higher than the baseline year, while in other schools they were just 13.0% higher. In Phase 5 schools, entries in 2019 were 19.7% higher than the 2017 baseline figure, compared to just 14.8% for all other schools.

Analysis b): Simple comparison between SPN and matched schools

- We found a relative increase in A-level physics entries in SPN schools compared to the matched comparison schools.
- In 2018, entry numbers in Phase 4 schools were 16.6% higher than in the baseline year, compared to 1.3% in the matched comparison group. In Phase 5 schools, entries in 2019 were 10.0% higher relative to the baseline year, compared to 2.1% in matched comparison schools.
- We also found a relative increase of the number of pupils achieving the top A*/A grades in A-level physics SPN schools. The number of pupils achieving the top grades in Phase 4 schools in 2018 was 31.1% higher than the baseline year, while in comparison schools it was 4.8% lower. In Phase 5 schools, the number achieving top grades in in 2019 was 1.4% lower than in the baseline year, while in comparison schools it was 3.3% lower.
- However, there was also a relative increase in the overall number of KS4 pupils in SPN schools during the period covered by the evaluation.

Analysis c): Detailed comparison between SPN and matched schools

- This part of the analysis did not find conclusive evidence to show that either SPN Phase 4 or SPN Phase 5 had a statistically significant positive effect on GCSE physics grade, progression to A-level physics, female progression to A-level physics or A-level physics grade.
- However, we did find a positive effect on the likelihood of female pupils progressing to complete an A-level in physics in SPN Phase 5 schools, and on the likelihood of achieving a top A-level grade for students who took A-levels at an SPN Phase 4 schools, although these estimates were not statistically significant.
- The odds of a female student from a Phase 5 school taking A-level physics were between 3 and 5% higher than those of a female student from a comparison school. The odds of a student who took a physics A-level at a Phase 4 school achieving a top grade were at their highest in the first outcome year that we looked at, 2015, at 20% higher than those of a student at a comparison school. In 2016, the odds were 9% higher and in 2017 they were 2% higher.
- We did not find any evidence of a differing effect by level of dosage, i.e. the number of teacher hours of CPD provision.
- This part of the analysis was less conclusive than analysis b) – this is not surprising, as the detailed comparison in c) controlled for differences that the simple comparison in b) did not.

1.3 Limitations

- Analysis a) compares SPN schools to all other schools, but it does not control for differences between SPN schools and other schools before the project began.
- Analysis a) and b) look at changes relative to a baseline year. For Phase 4, outcomes in 2018, four years after the intervention began, are compared to the baseline. For Phase 5, outcomes in 2019, just three years after the invention began, are compared to the baseline. This is because more recent data is not yet available. This could lead to underestimation of effects for Phase 5 if effects become stronger over time.

- Analysis b) and c) compare SPN schools to a matched comparison group. Ideally, from an evaluation perspective, schools would have been randomly assigned to a treated group or a comparison group, rather than a comparison group being constructed using NPD data.
- In addition, analysis b) does not control for the uncertainty inherent in the matching process or for changes in pupil characteristics.
- Creating a comparison group in this way means that we were unable to control for factors not observed or recorded in our data.
- The SPN project targeted schools in need of support with physics teaching, particularly those with few or no specialist physics teachers. Recruitment was done by a team based around the country often using local knowledge to identify suitable schools. We had no way of replicating this selection process using data.
- A number of SPN schools also took part in earlier phases of the project. We excluded these schools from the bulk of the analysis, considerably reducing the sample size. It is possible that this led to an underestimation of effects if these schools benefited particularly from the intervention.
- The dosage data provided was an imperfect measure of how much schools had engaged, and so may give misleading results.
- Some comparison schools may have taken part in similar projects. If this improved outcomes in comparison schools, it may have led to underestimation of effects.
- The effects observed should be considered tentative given these limitations.

2 Introduction

The Stimulating Physics Network is a long-running project that has been managed by the Institute of Physics (IOP) and funded by the Department for Education (DfE), from 2009. It provides support to teachers of physics in participating secondary schools, particularly non-specialists, including CPD workshops and advice from a dedicated physics coach. This evaluation is concerned with the following phases of the project: Phase 4 (2014-16) and Phase 5 (2016-19).

Our analysis used data from the National Pupil Database (NPD) to compare the performance of pupils in schools that took part in the project to the performance of pupils in other schools. This was done in three ways:

a) Comparison of the change in number of entries to A-level physics in SPN schools and all other schools, relative to a baseline year (2015 for Phase 4, 2017 for Phase 5) – results are given in section 3;
b) Simple comparison of change in attainment in GCSE physics, number of entries to A-level physics from various groups of students, and A-level grades in SPN schools and a matched comparison group, relative to a baseline year (2015 for Phase 4, 2017 for Phase 5) – results are given in section 5;
c) Full comparison of attainment at GCSE physics, the likelihood of pupils progressing to complete an A-level in physics, both overall and for female pupils, and the likelihood of those students who went on to take a physics A-level achieving an A or A* in SPN schools and a matched comparison group, using multilevel regression models adjusted to take account of pupil-level characteristics and bootstrapping to account for uncertainty in the matching process, and looking at how impact varied by dosage (where available) – results are given in section 6.

For Phase 4, we consider the impact on these outcome measures in each year from 2014-19, and for Phase 5, in each year from 2016-19.

In analysis c) we looked at the impact by dosage, where possible: that is, by how much schools engaged with the projects. For Phase 4, data on dosage was limited to a binary indicator of whether a school engaged with the project or not. For this phase, we estimated the impact for all participating schools and the impact for the engaged schools. More detailed data on dosage was available for Phase 5; for each school, data was provided on the total number of 'teacher hours' completed. 'Teacher hours' are simply calculated by multiplying the number of teachers who took part in a session by the number of hours the session lasted. Using this measure, we grouped schools into those with low (0 - 22.5 teacher hours), medium (22.5 - 52 teacher hours) or high dosage (52+ teacher hours). For this phase, we estimated the impact for all participating schools and for schools in each of the dosage groups.

We did not look at the impact of dosage for the fourth outcome, the likelihood of those students who went on to take a physics A-level achieving an A or A*. This is because the relatively low numbers involved meant that breaking down the students further by dosage level would not have given us sufficient numbers to complete any useful analysis.

2.1 Methodology

Parts b) and c) of the analysis used what is known as a quasi-experimental design. This involves comparing the outcomes of pupils who went to a school that took part in the relevant phase to those of pupils from a matched comparison group of statistically similar schools. This approach mimics what would be done in a formal experiment such as a randomised control trial.

We selected schools that were similar with respect to:

- School characteristics (region, selection policy, whether it has a sixth form, gender)
- Proportion of pupils eligible for Pupil Premium
- Proportion of pupils with a first language other than English
- Average prior attainment of pupils at Key Stage 2
- Summary KS4 attainment in physics and the proportion of pupils taking GCSE physics for the previous three years
- Summary rates of progression to A-Level physics for the 3 years before the start of the phase[1]
- Summary proportion of female students progressing to A-Level physics for the previous three years

Only mainstream state-funded schools in England were considered for the comparison group. We also excluded any schools that participated in SPN, even those who were not included in the final analysis, or that participated in the related Improving Gender Balance project.

For analysis c) we fitted models to the data. For physics grade, we used multilevel regression models (pupils within schools) to compare outcomes for pupils who went to a school that took part in one of the projects to pupils who went to a school in the matched comparison group. In each case, we used a dummy variable to indicate whether a pupil's school had taken part in the projects, and we controlled for the following pupil characteristics: prior attainment at Key Stage 2, gender, Pupil Premium status and whether English is an additional language. Confidence intervals were obtained for our estimates by using bootstrapping.

For progression to A-level physics, we used logistic regression models, with the same dummy variable to indicate treatment status and control variables as for physics grade.

2.2 Data

The IOP initially provided two datasets, consisting of all schools that took part in SPN Phase 4 and SPN Phase 5. This included school identifiers (school name, URN and LAESTAB), dates in which the school joined and left the project, and data on dosage, where available. This data was linked to corresponding records in the National Pupil Database (NPD), and to publicly available school-level data.

The NPD is an administrative data resource maintained by the Department for Education and provides a history of enrolments, attendance, exclusions and attainment in national tests and public examinations (e.g. GCSE and A-level) for all pupils who have been in state-funded education since 2002. For this project, we used data on attainment at GCSE and subject choice at A-Level, as well as

[1] For Phase 4, this was the rate of progression for pupils who completed KS4 in 2011-13 and for Phase 5, the rate of progression for pupils who completed KS4 in 2013-15.

prior attainment during Key Stage 2. We also used the demographic variables mentioned in section 2.1; that is, gender, Pupil Premium status and English as an additional language.

The original datasets consisted of 358 schools for Phase 4 and 896 for Phase 5. Following discussions with the IOP, the Phase 5 list was edited to remove all schools not classed as SPN Partner Schools (i.e. not direct recipients of the SPN programme of physics CPD). A small number of Phase 4 and Phase 5 schools were excluded because they either had no Key Stage 4 pupils (eg middle schools, further education colleges), because they were not mainstream (eg special schools, pupil referral units), or because they were new schools that opened after 2017, with no predecessors.

After these edits, a dataset of 355 Phase 4 schools and 726 Phase 5 schools remained. This dataset was used for analysis a) as presented in section 3 of this report; the analysis in this section is designed to be comparable to that done in previous evaluations of the project.

For analyses b) and c), a smaller dataset was used. To create this dataset, we removed any schools that joined the project before the start of the relevant phase, or for which no valid join date was available. Finally, the Phase 5 list was edited to remove any schools that had also taken part in Phase 4 or in a related project known as Improving Gender Balance (IGB).

The final dataset used for analyses b) and c) consisted of 286 Phase 4 schools and 268 Phase 5 schools.

3 Comparison of exam entries in SPN schools and all other schools

We will begin with a comparison of A-level entry numbers in SPN schools and all other state-funded, mainstream schools in England. This is the analysis described as a) in the methodology section.

In this section, we include all state-funded schools, including those that participated in earlier phases of SPN. This is so that the data provided in this section is comparable with earlier evaluations of previous phases of the project. Elsewhere, we only include those who participated in Phase 4 or Phase 5 (in other words we exclude SPN schools that also took part in an earlier phase of the project, or for which no date of joining was available). See section 2.2 for full details of how the datasets used here and elsewhere in this report were constructed.

Tables 1 and 2 show the percentage change relative to a baseline year (2015 for phase 4, 2017 for phase 5) in SPN schools and all other schools. Figures shown in brackets are the actual number of students who took an A-level physics exam. The years shown here are the year in which students completed their A-levels. In table 1, 'all other schools' includes all schools that did not take part in SPN Phase 4. In table 2, 'all other schools' includes all schools that did not take part in either SPN Phase 4 or SPN Phase 5.

Table 1: Percentage change in number of entries to A-level physics from baseline year, Phase 4 schools and all other state-funded schools (figures shown in brackets are actual number of entries)

		2015	2016	2017	2018	2019
All other schools	All pupils	0.0% (20987)	-3.1% (20345)	3.9% (21805)	11.6% (23424)	13.6 (23830)
Phase 4 schools	All pupils	0.0% (1835)	-5.9% (1727)	3.5% (1900)	17.4% (2154)	13.4% (2081)
All other schools	Female pupils	0.0% (4274)	-5.2% (4053)	0.7% (4305)	13.0% (4831)	16.5% (4980)
Phase 4 schools	Female pupils	0.0% (319)	4.1% (332)	13.8% (363)	29.2% (412)	32.0% (421)
All other schools	Male pupils	0.0% (16713)	-2.5% (16292)	4.7% (17500)	11.3% (18593)	12.8% (18850)
Phase 4 schools	Male pupils	0.0% (1516)	-8.0% (1395)	1.4% (1537)	14.9% (1742)	9.5% (1660)

As shown in table 1, the number of students taking A-level physics decreased in 2016 relative to 2015, our baseline year, but increased in every year since. The pattern in SPN Phase 4 schools was broadly similar to that in all other schools, although there was a peak in 2018, when numbers increased by 17.4% relative to the baseline year in SPN schools compared to just 11.6% in all other schools.

More marked differences can be seen when we look at the numbers broken down by gender. In all other schools, entries for both male and female students fell in 2016 and then increased each subsequent

year. However, in SPN Phase 4 schools, the number of entries from female students actually increased by 4.1% in 2016 relative to 2015, and then continued to increase each year. In 2018, entries from female students in all other schools were 13.0% higher than in 2015; in SPN Phase 4 schools, they were 29.2% higher. In 2018, entries from male students were also higher in SPN schools than in all others; they increased by 11.3% in all other schools compared to 14.9% in SPN schools. This does buck the overall trend, though: in every other year shown in table 1, entries from male students in SPN schools increased less (or decreased more) than those from male students in all other schools.

Table 2: Percentage change in number of entries to A-level physics from baseline year, Phase 5 schools and all other schools (figures shown in brackets are actual number of entries)

		2017	2018	2019
All other schools	All pupils	0.0% (19308)	7.4% (20745)	9.6% (21169)
Phase 5 schools	All pupils	0.0% (4087)	9.5% (4477)	7.8% (4405)
All other schools	Female pupils	0.0% (3788)	12.1% (4246)	14.8% (4350)
Phase 5 schools	Female pupils	0.0% (817)	13.7% (929)	19.7% (978)
All other schools	Male pupils	0.0% (15520)	6.3% (16499)	8.4% (16819)
Phase 5 schools	Male pupils	0.0% (3270)	8.5% (3548)	4.8% (3427)

Phase 5 schools showed a similar pattern, as shown in table 2. Relative to 2017, our baseline year for this phase, entries to A-level physics increased each year in all other schools, rising from 19308 in 2017 to 21169 in 2019. In Phase 5 schools, they increased in from 4087 in 2017 to 4477 in 2018 but then fell back slightly, to 4405 in 2019.

Again, we see some interesting differences when we look at the data broken down by gender. In all other schools, both the number of female and the number of male students increased each year from 2017. In SPN Phase 5 schools, the number of female students increased each year, and in 2019 stood at 19.7% higher than the 2017 baseline figure, compared to 14.8% for all other schools. However, the number of male students in 2019 was just 4.8% higher than 2017 in SPN Phase 5 schools, compared to 8.4% in all other schools.

4 Creating a matched comparison group

In this section, we will start with an overview of how schools that took part in SPN compared to other state-funded, mainstream schools in England. We then go on to discuss the matching technique used and how successful it was in creating a matched comparison group.

From this point onwards, we will use the terms *treated schools* and *SPN schools* interchangeably. We will also use the term *potential comparison schools* to refer to all other state-funded, mainstream schools.

4.1 Difference between treated and potential comparison schools

In this section, and for the rest of the report, we will be using a smaller dataset than that used in section 3. This dataset excludes SPN schools that took part in earlier phases or the project, or for which no join date was available. See section 2.2 for a full description of how the datasets used in this report were constructed.

Here, we will describe how the SPN schools in the smaller dataset compared to potential comparison schools before matching was completed.

The SPN project had specific selection criteria: it sought to work with the schools that were most in need of support. Among other criteria, SPN targeted schools in which a low proportion of students progressed to A-level physics. It is not surprising, then, that SPN schools tended to send fewer pupils on to study A-level physics than potential comparison schools. On average, 2.9% of pupils who completed KS4 at a Phase 4 SPN school in 2013, the year before the phase began, went on to complete an A-level in physics in 2015, compared to 4.4% of potential comparison schools. Similarly, for Phase 5 schools, 3.6% of those who completed KS4 in 2015, the year before the phase began, went on to take an A-level in physics, compared to 4.7% of potential comparisons.

SPN schools also tended to send fewer female pupils on to study A-level physics; 1.0% of those female students who completed KS4 at an SPN Phase 4 school in 2013 went on to complete an A-level in physics in 2015 compared to 1.9% in potential comparison schools. In Phase 5 schools, the figure was 1.5% for those who completed KS4 in 2015 and went on to complete A-levels in 2017, compared to 1.9% in potential comparison schools. The gender balance of students going on to complete an A-level in physics was lower in Phase 4 schools; 18.4% of those going on to complete an A-level in physics were female, compared to 20.2% in potential comparison schools, for pupils who completed KS4 in 2013 and A-levels in 2015. However, in Phase 5 schools the gender balance was slightly better than in potential comparison schools; 20.7% of those pupils who completed KS4 in 2015 and went on to take an A-level in physics were female, compared to 19.7% in potential comparison schools.

Attainment at physics GCSE tended to be slightly lower in SPN schools; in 2013, just 39.1% of pupils in Phase 4 schools achieved an A grade or higher, compared to 41.7% in potential comparison schools. For Phase 5 schools in 2015, the figures were 38.4% in SPN schools and 44.4% in potential comparison schools. However, pupils at SPN schools also tended to have slightly lower prior attainment at Key Stage 2 than average; 22% of SPN pupils were in the lowest quintile for KS2 attainment, and just 17% were in the highest.

The project tended to work with schools with a higher proportion of disadvantaged pupils; 28.9% of Phase 4 pupils were eligible for the Pupil Premium in 2013, compared to 25.6% of pupils in potential comparison schools. In SPN Phase 5 schools, 27.2% were eligible in 2015, compared to 25.6% in potential comparison schools. Pupils in SPN schools were also slightly less diverse in terms of ethnic background (76.5% white British in Phase 4 schools in 2013, compared to 74.1% in potential comparisons, and 76.8% white British in Phase 5 schools in 2015, compared to 71.1% in potential comparisons).

SPN schools were less likely to be single sex than other schools; over 90% of SPN schools were mixed compared to 86% of potential comparison schools. They were slightly more likely to have a sixth form than other schools (36% of Phase 4 and 38% of Phase 5, compared to 33% of potential comparison schools) and very few were selective.[2]

4.2 Extent of success in creating matched comparisons

The matching process was carried out using the nearest neighbour method, pairing treated and comparison schools based on propensity scores. Propensity scores are calculated by using a logistic regression model to determine a school's likelihood of being in the treated group, based on the variables used for matching. A propensity score can be thought of as a measure of how typical each school is of schools in the treated group. As shown in section 4.1, SPN schools tended to have a higher proportion of disadvantaged pupils than average, to have a low proportion of pupils progressing to A-level physics and were very unlikely to be selective. So, a selective school with a low proportion of disadvantaged pupils and a high rate of progression to A-level physics would probably have a low propensity score, and vice versa. The nearest neighbour method begins by calculating propensity scores for all schools, both treated and potential comparison. Then it simply pairs each treated school with the potential comparison school with the nearest propensity score.

Before fitting the propensity score models, we removed potential comparison schools that were ineligible for support from the relevant project, for example, independent schools. Schools were then matched on the variables described in section 2.1.

The graphs in figure 1, known as love plots[3], show how similar the treated and comparison schools were to one another, before and after matching, using a measure called the standardised mean difference. The mean difference is simply the difference between the average value of the variable for the treated schools, and the average value for the comparison schools. Standardising this measure means that we can compare balance across different variables. Generally, a standardised mean difference of 0.2 or below is considered to indicate good balance. This threshold is shown on the graphs as a dotted line.

As shown in figure 1, the matching process successfully created well-matched comparison groups for SPN Phase 4 and 5 schools. All of the standardised mean differences were below the 0.2 threshold after matching was carried out.

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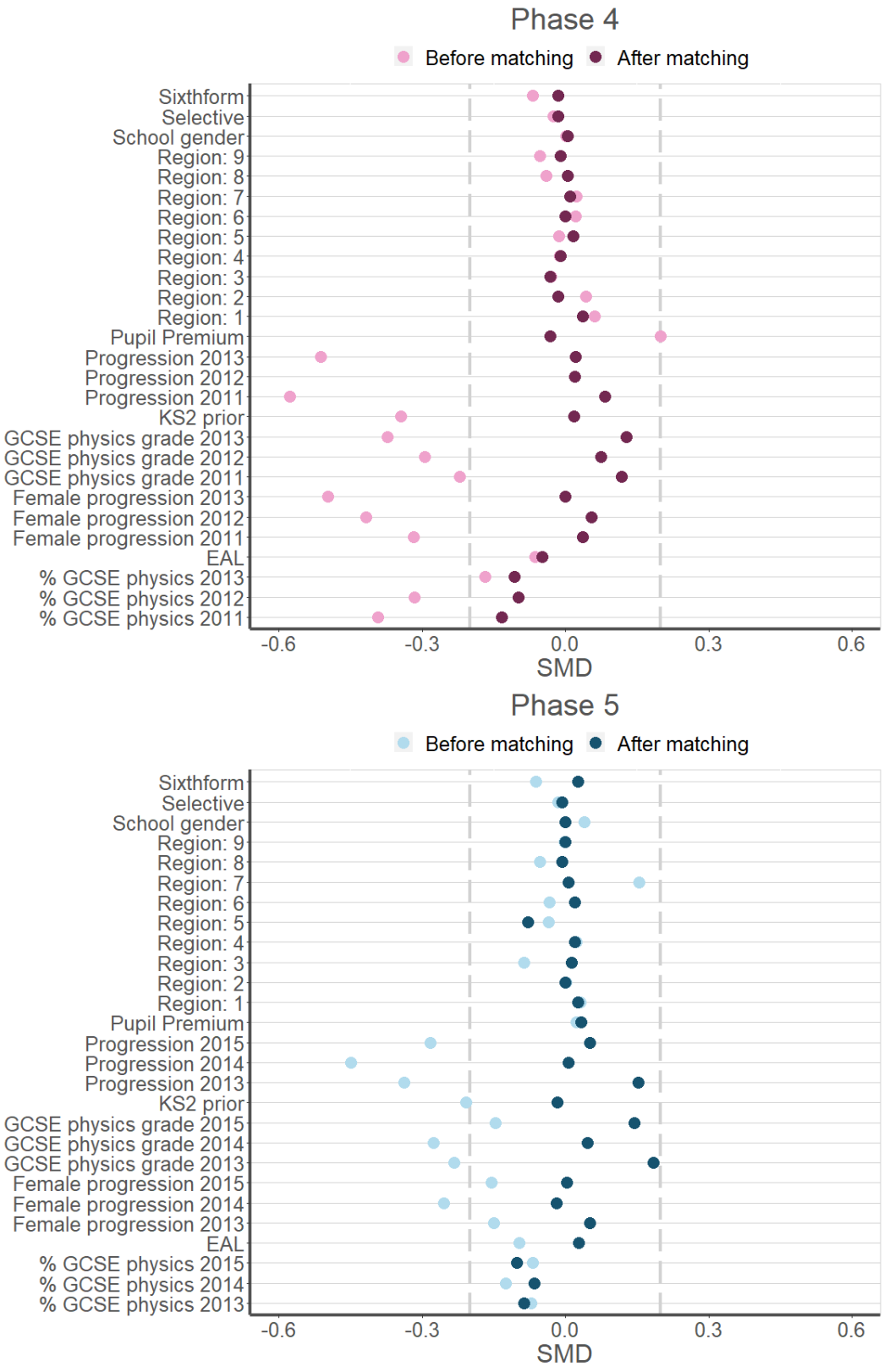
[2] Due to low numbers, the exact proportion of schools that were selective has been suppressed. This has been done to comply with requirements for using NPD data for research; counts lower than ten, or statistics based upon them, cannot be published.

[3] Loveplots are named for Professor Thomas E. Love, who first developed them along with colleagues (**https://academic.oup.com/eurheartj/article/27/12/1431/647407**)

Figure 1: Loveplots showing the extent of success in creating a matched comparison group



5 Raw differences between SPN schools and comparison schools

This section compares the treated schools to the schools in the matched comparison group – described as analysis b) in the methodology section. We also look at how these groups compare to all other mainstream state-funded schools in England. Comparing the groups in this way, particularly the trends in the years during and immediately after the projects, gives an indication of the effect that the projects had.

However, we should be cautious about drawing conclusions based on such a comparison. Firstly, making a comparison in this way does not take account of changes in pupil level characteristics. For example, if the prior attainment of the pupils entering the Phase 4 schools increased between 2015 and 2018, we might also expect that GCSE physics grades would increase, regardless of the effect of the project. Fitting regression models that control for these differences allows us to give more robust estimates of the project's impact.

Secondly, the comparisons shown in this section do not incorporate any uncertainty. A robust evaluation needs to take account of the uncertainty inherent in the matching and modelling process to produce estimates complete with confidence intervals. The results shown in section 6 control for differences in pupil characteristics and uncertainty from the matching and modelling process by using regression models combined with bootstrapping, a technique that involves repeatedly sampling the data and reproducing the analysis.

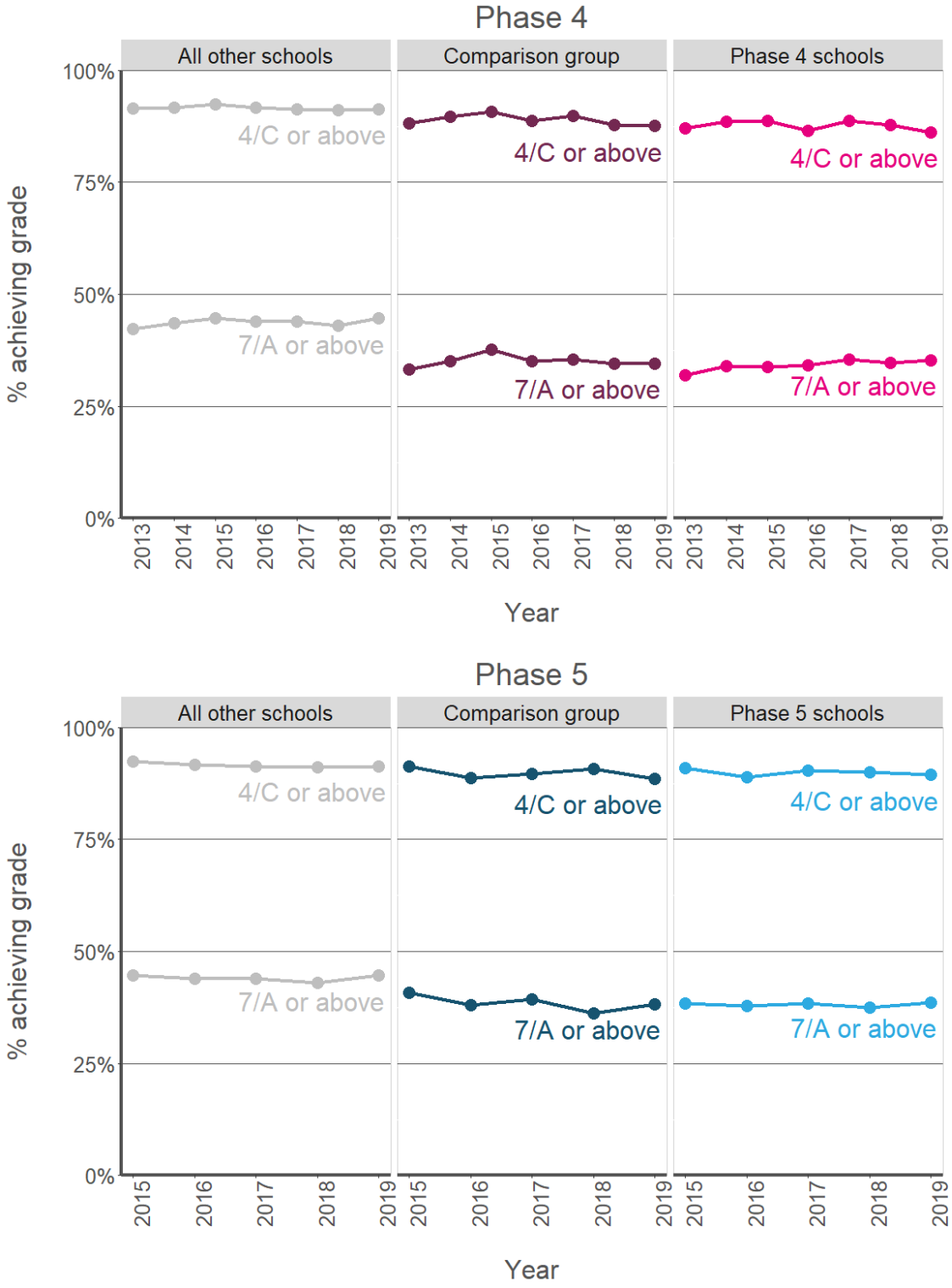
The summary statistics used to make the comparisons in this section are also included as an appendix to this report.

5.1 GCSE grades

Figure 2 shows how GCSE physics grades in SPN schools compared to the matched comparison groups and to all other schools.

The proportion of pupils achieving a grade 7/A or above was relatively low in SPN schools and comparison schools; in 2018, for example, just 34.7% of pupils in Phase 4 schools, compared to 43.1% in all other schools. In 2019, 38.7% of pupils in Phase 5 schools achieved this grade, compared to 44.6% in all other schools. Differences were less clear at grade 4/C and above, although pupils in SPN schools were still slightly less likely to reach this level; in 2018, 87.8% of pupils from Phase 4 schools reached grade 4/C, compared to 91.2% from all other schools, and in 2019 89.4% of pupils in Phase 5 schools achieved this level, compared to 91.3% of pupils in all other schools.

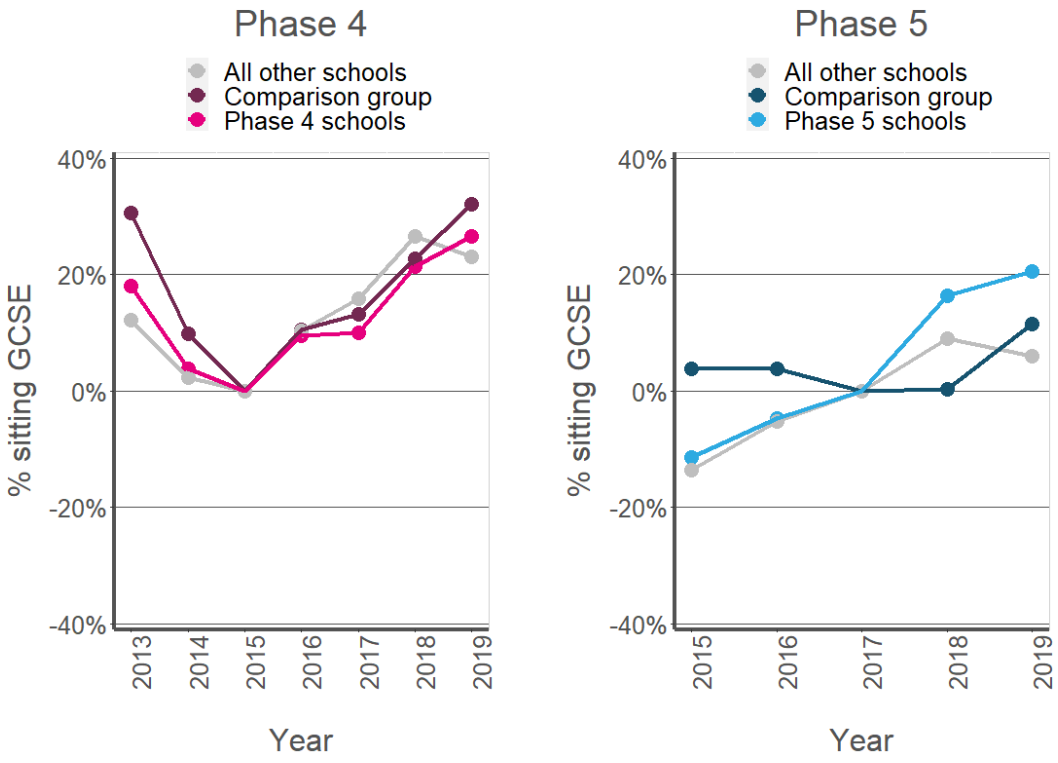
Figure 2: Mean GCSE physics grades



These changes in attainment should be seen in the context of changes to the proportion of pupils studying the subject at GCSE. Between 2015 and 2019, this proportion increased every year, moving from 18.7% to 23.6% in Phase 4 schools, and from 18.3% to 24.9% in Phase 5 schools. Pupils in non-SPN

schools were more likely to study the subject at GCSE than those in SPN schools; 28.0% did so in 2019, for example. This is shown in figure 3.

Figure 3: Change in proportion of pupils sitting GCSE physics relative to baseline year



5.2 Entry to A-level physics

The years shown in this section indicate the year in which pupils completed their A-levels. The most recent data available is for 2019: these are for pupils who completed KS4 in 2017 and who would have completed A-levels in 2019.

5.2.1 Overall

Comparing the number of pupils entering A-level physics in SPN schools and matched comparison schools does show a relative increase in numbers for Phase 4 schools. Compared to the numbers in 2015, the year before the phase began, entries in Phase 4 schools had increased 16.6% by the end of the phase in 2018. In the matched comparison group, the increase in the same period was just 1.3%, and in all other schools it was 11.6%. In 2019, entry numbers in Phase 4 schools dipped compared to 2018; the increase compared to 2015 was 10.9%. In the matched comparison group, it was 4.8% and 13.3% in all other schools.

In Phase 5 schools there was also a relative increase in numbers; compared to 2017, the year before the phase began, entries had increased by 10.0% in Phase 5 schools by the end of the phase in 2019, compared to 2.1% in comparison schools and 9.6% in all other schools.

Table 3: Pupils entering A-level physics from SPN schools

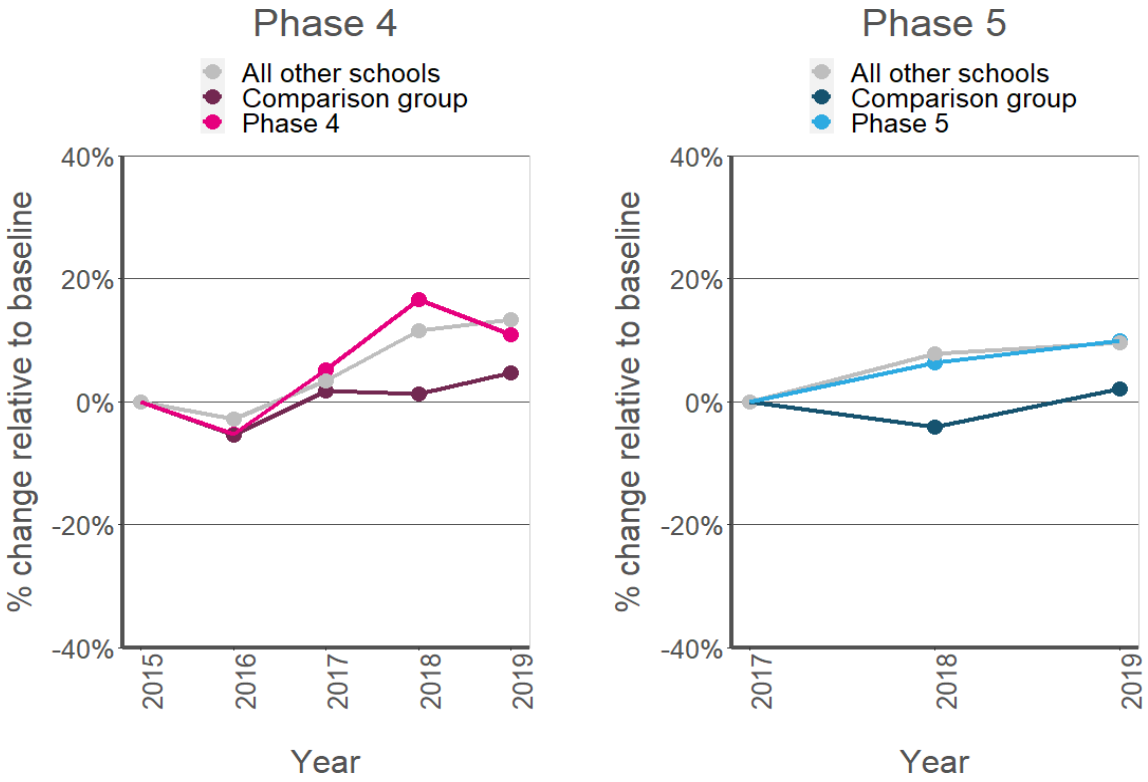
Phase 4

	2015	2016	2017	2018	2019
Number of pupils entering A-level physics	1373	1302	1444	1601	1522
% change in number of pupils entering A-level physics from 2015	-	-5.2%	5.2%	16.6%	10.9%
Total number of KS4 pupils	47828	46737	46759	46018	43758
Proportion entering A-level physics	2.9%	2.8%	3.1%	3.5%	3.5%

Phase 5

	2017	2018	2019
Number of pupils entering A-level physics	1606	1709	1767
% change in number of pupils entering A-level physics from 2017	-	6.4%	10.0%
Total number of KS4 pupils	45044	43670	42779
Proportion entering A-level physics	3.6%	3.9%	4.1%

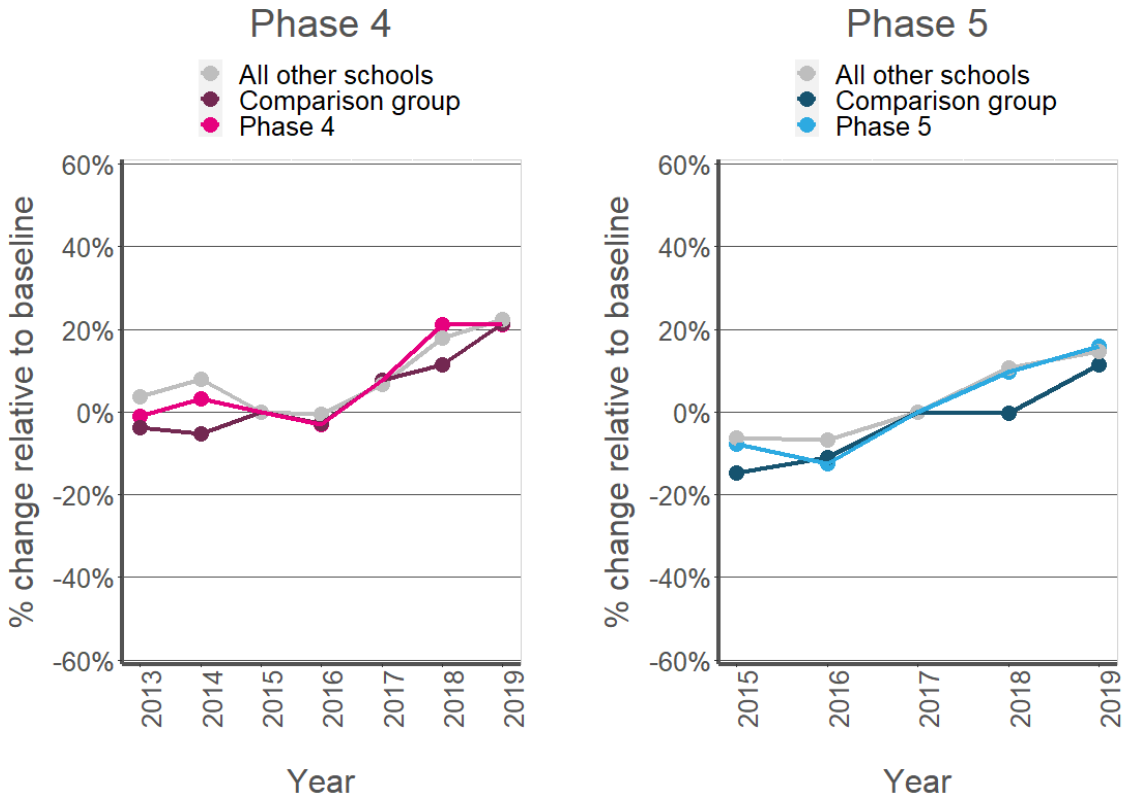
Figure 4: Change in A-level entries from SPN schools relative to baseline year



However, changes in entry numbers should be seen in the context of the size of the pupil population. In the comparison schools for Phase 4, for example, the number of pupils completing Key Stage 4 fell by 9.2% between 2015 and 2018, while the number in Phase 4 schools fell by just 3.8%. It may be that the relatively low numbers entering A-level physics for comparison schools are simply a consequence of there being relatively few pupils overall. For this reason, it is useful to look at changes in the proportion of pupils who went on to enter A-level physics.

Figure 5 shows that the proportion of pupils going on to enter A-level physics was lower for SPN schools and those in the comparison groups than for all other schools. This proportion increased in every year from 2016, for SPN schools, comparison schools and other schools alike. For Phase 4 schools, for example, it increased from 2.8% in 2016 to 3.5% in 2018, and from 3.3% to 3.8% for matched comparison schools, compared to an increase from 4.4% to 5.2% for all other schools. Similarly, the proportion of entries in Phase 5 schools increased from 3.1% in 2016 to 4.1% in 2019; it was increasing before SPN Phase 5 began.

Figure 5: Change in proportion of students entering A-level physics relative to baseline year



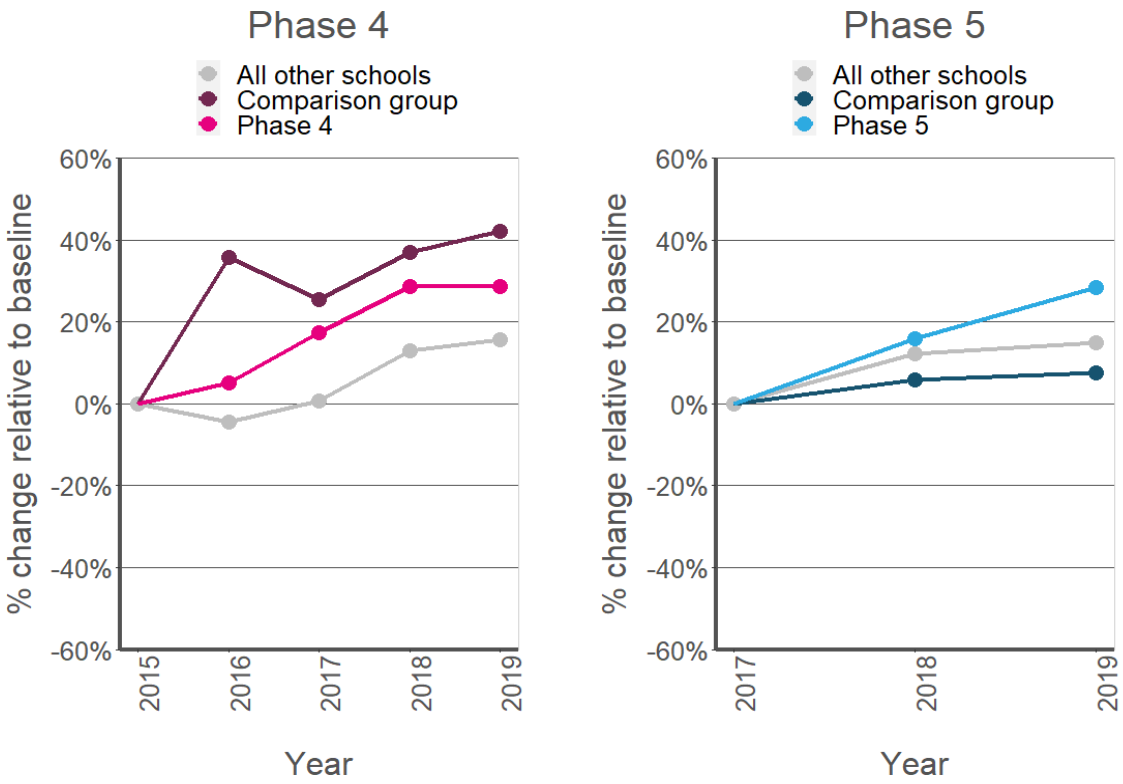
5.2.2 Female pupils

As shown in table 4 and figure 6, there was a general increase in the number of female students studying A-level physics during Phases 4 and 5 of SPN. In Phase 4 schools, there was an increase of 28.6% in 2018 from 2015, the year before the phase began, compared to an increase of 13.0% in all other schools. However, the increase in the matched comparison schools was even higher at 37.0%. The increase in 2019 compared to 2015 was also 28.6% for SPN partner schools, compared to 15.7% for all other schools and 42.0% for matched comparison schools. There was a large relative increase in the

number of entries in comparison schools in 2016, but given the relatively low number of students involved and the fact that the trend continues fairly linearly both before and after 2016, this is likely to just be noise.

In Phase 5 schools, the increase in 2019 compared to 2017, the year before the phase began, was 28.3%, while for comparison schools it was just 7.6% and for all other schools it was 14.9%.

Figure 6: Change in female A-level entries from SPN schools relative to baseline year



As before, the increase should be considered in the context of the size of the pupil population; for example, the number of female pupils completing Key Stage 4 in Phase 5 schools fell by a lower proportion than that in comparison schools over the same time period (-5.2% compared to -8.0% in comparison schools). For this reason, it is useful to consider the proportion of female pupils who go on to enter A-level physics. We also provide information on the proportion of A-level physics entrants who were female for context.

As shown in figure 7a, the proportion of female pupils entering A-level physics was slightly lower in SPN Phase 4 and Phase 5 schools than for comparison schools or all other schools, for each year from 2013-19. Although the proportion increased in SPN schools during the course of the project, this was also the case in other schools. In Phase 4 schools, the proportion increased from 1.0% in the year before the project began to 1.4% in 2018, but it also increased from 1.1% to 1.7% in comparison schools, and from 1.8% to 2.1% in all other schools. In Phase 5 schools, it increased from 1.5% the year before the phase began to 2.0% in 2019, compared to an increase from 1.9% to 2.3% in comparison schools, and from 1.9% to 2.2% in all other schools.

Table 4: Female pupils entering A-level physics from SPN schools

Phase 4

	2015	2016	2017	2018	2019
Number of pupils entering A-level physics	1373	1302	1444	1601	1522
Number of female pupils entering A-level physics	252	265	296	324	324
Number of male pupils entering A-level physics	1121	1037	1148	1277	1198
Total number of KS4 pupils	47828	46737	46759	46018	43758
% change in number of female pupils entering A-level physics from 2015	-	5.2%	17.5%	28.6%	28.6%
% of female students	18.4%	20.4%	20.5%	20.2%	21.3%
% change in number of male pupils entering A-level physics from 2015	-	-7.5%	2.4%	13.9%	6.9%
Progression rate of female students	1.0%	1.1%	1.2%	1.4%	1.4%

Phase 5

	2017	2018	2019
Number of pupils entering A-level physics	1606	1709	1767
Number of female pupils entering A-level physics	332	385	426
Number of male pupils entering A-level physics	1274	1324	1341
Total number of KS4 pupils	45044	43670	42779
% change in number of female pupils entering A-level physics from 2017	-	16.0%	28.3%
% of female students	20.7%	22.5%	24.1%
% change in number of male pupils entering A-level physics from 2017	-	3.9%	5.3%
Progression rate of female students	1.5%	1.7%	2.0%

Similarly, the proportion of A-level physics entrants who were female increased during the course of the project; this was the case for SPN schools and other schools alike. The proportion in Phase 4 schools increased from 18.4% in the year before the phase began to 20.2% in 2018, while in comparison schools it increased from 17.5% to 23.6%, and from 20.2% to 20.5% in all other schools. In Phase 5 schools, it increased from 20.7% in the year before the phase began to 24.1% in 2019, while in comparison schools it increased from 24.4% to 25.8%, and from 19.7% to 20.6% in all other schools.

Figure 7a: Change in proportion of female students entering A-level physics relative to baseline year

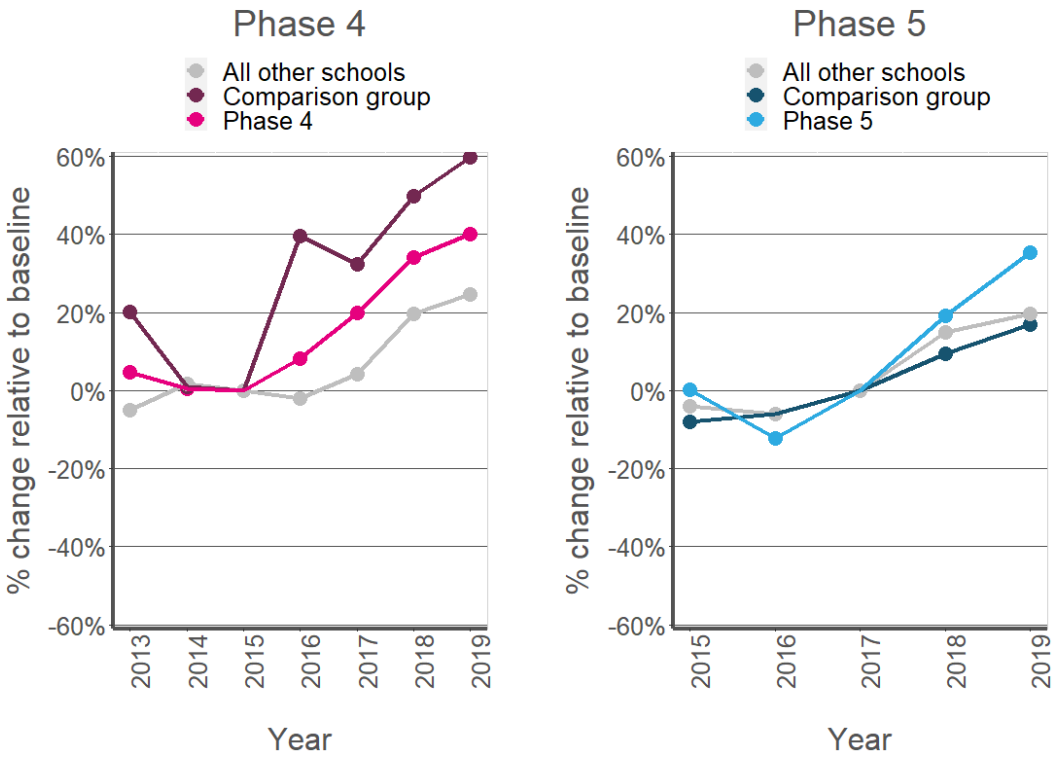
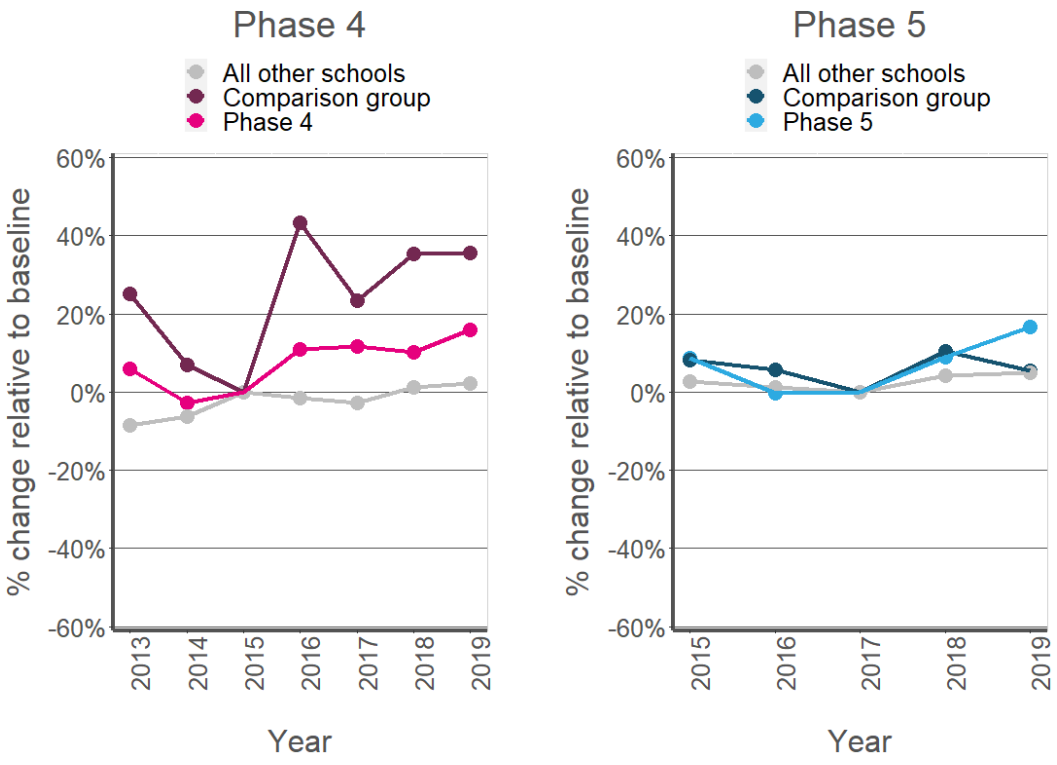


Figure 7b: Change in proportion of A-level physics students who were female relative to baseline year



5.2.3 Disadvantaged pupils

Comparing the number of disadvantaged pupils entering A-level physics in SPN schools and matched comparison schools shows that increases in SPN schools tended to be higher than those in comparison schools for Phase 4 and lower for Phase 5 of the project.

Compared to the numbers in 2015, the year before the phase began, entries in Phase 4 schools had increased by 20.7% in 2018, compared to 15.3% in the matched comparison group. In all other schools, the increase in the same period was also 20.7%. However, in 2019, entries in Phase 4 schools fell; an increase of just 10.4% compared to 2015, while entries in the matched comparison group had increased 25.2%, and in all other schools by 21.9%. In Phase 5 schools; compared to 2017, the year before the phase began, entries increased by 17.2% in Phase 5 schools, compared to 20.0% in comparison schools and 14.4% in all other schools.

Table 5: Disadvantaged pupils entering A-level physics from SPN schools

Phase 4

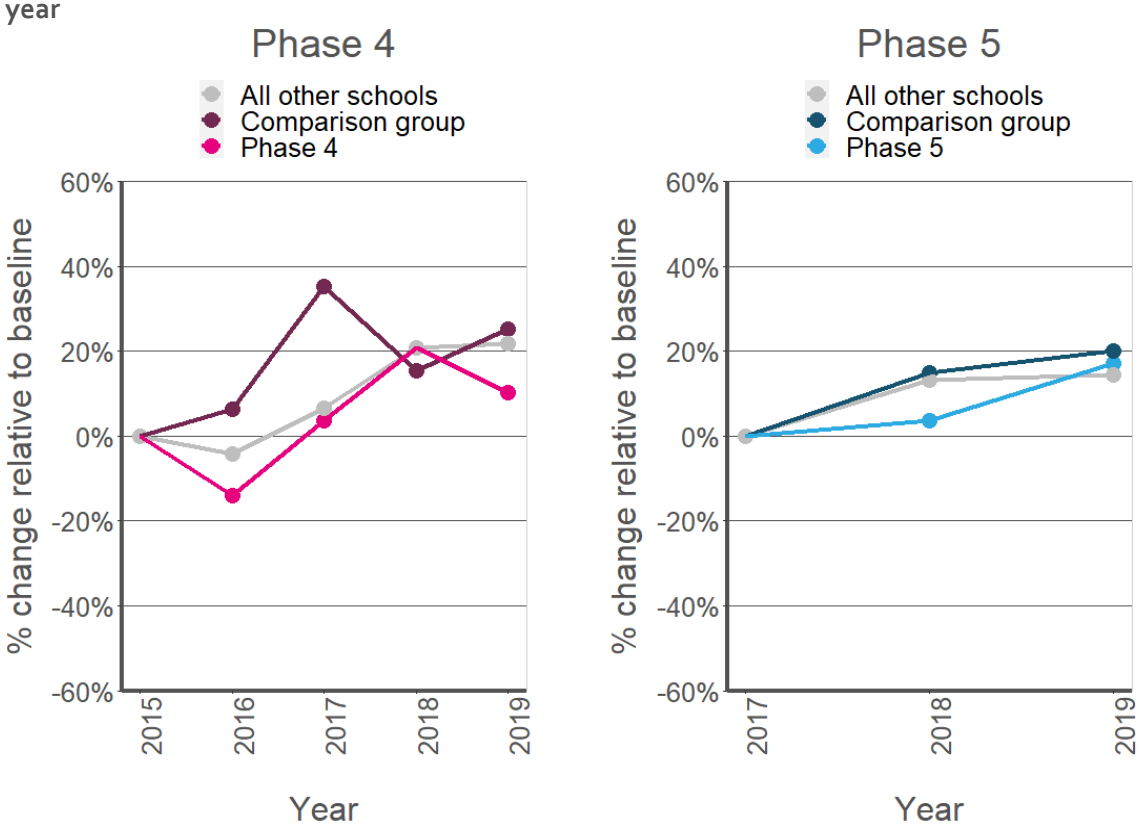
	2015	2016	2017	2018	2019
Number of pupils entering A-level physics	1373	1302	1444	1601	1522
Number of disadvantaged pupils entering A-level physics	164	141	170	198	181
Number of non-disadvantaged pupils entering A-level physics	1209	1161	1274	1403	1341
Total number of KS4 pupils	47828	46737	46759	46018	43758
% change in number of disadvantaged pupils entering A-level physics from 2015	-	-14.0%	3.7%	20.7%	10.4%
% of disadvantaged students	11.9%	10.8%	11.8%	12.4%	11.9%
% change in number of non-disadvantaged pupils entering A-level physics from 2015	-	-4.0%	5.4%	5.4%	10.9%
Progression rate of disadvantaged pupils	1.2%	1.0%	1.2%	1.5%	1.4%

Phase 5

	2017	2018	2019
Number of pupils entering A-level physics	1606	1709	1767
Number of disadvantaged pupils entering A-level physics	163	169	191
Number of non-disadvantaged pupils entering A-level physics	1443	1540	1576
Total number of KS4 pupils	45044	43670	42779

	2017	2018	2019
% change in number of disadvantaged pupils entering A-level physics from 2015	-	3.7%	17.2%
% of disadvantaged students	10.1%	9.9%	10.8%
% change in number of non-disadvantaged pupils entering A-level physics from 2015	-	6.7%	9.2%
Progression rate of disadvantaged pupils	1.3%	1.4%	1.7%

Figure 8: Change in disadvantaged students' A-level entries from SPN schools relative to baseline year



As before, the changes described above should be considered in the context of the size of the pupil population. For example, the number of disadvantaged pupils fell in all schools between 2015 and 2019, but it fell less sharply in SPN Phase 4 schools (-7.6% compared to -12.9% in matched comparison schools and -8.9% in all other schools).

The number of disadvantaged pupils entering A-level physics from SPN schools was low; the 10.4% increase from 2015 to 2019 represents an increase of just 149 pupils across the 312 Phase 4 schools. Translating these small numbers in percentage increases may be misleading. For these reasons, it is

useful to consider the proportion of disadvantaged pupils who go on to enter A-level physics. We also provide information on the proportion of A-level physics entrants who were disadvantaged for context.

As shown in figure 9a, the proportion of disadvantaged pupils entering A-level physics from SPN schools tended to be slightly lower than from other schools. In 2019, for example, it was 1.4% for SPN Phase 4 schools, compared to 1.7% for matched comparison schools, and for SPN Phase 5, it was 1.7% compared to 1.9% for matched comparison schools. However, as shown in figure 9b, the proportion of A-level physics students who were disadvantaged tended to be higher in SPN Phase 4 schools than in comparison schools; in 2019, it was 12.4% in Phase 4 and 10.2% in comparison schools. The picture was less clear for Phase 5 schools; in some years it was higher than comparison schools, and some years lower. In 2019, it was slightly higher at 10.8%, while in comparison schools it was 10.4%.

Figure 9a: Change in proportion of disadvantaged students entering A-level physics relative to baseline year

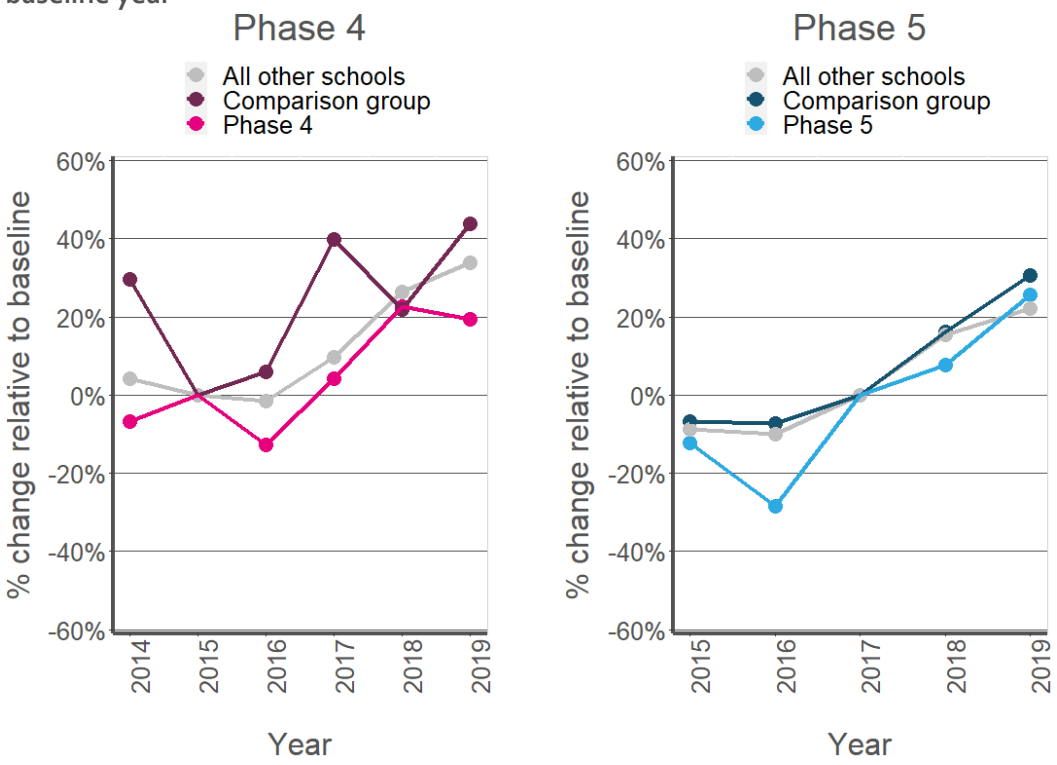
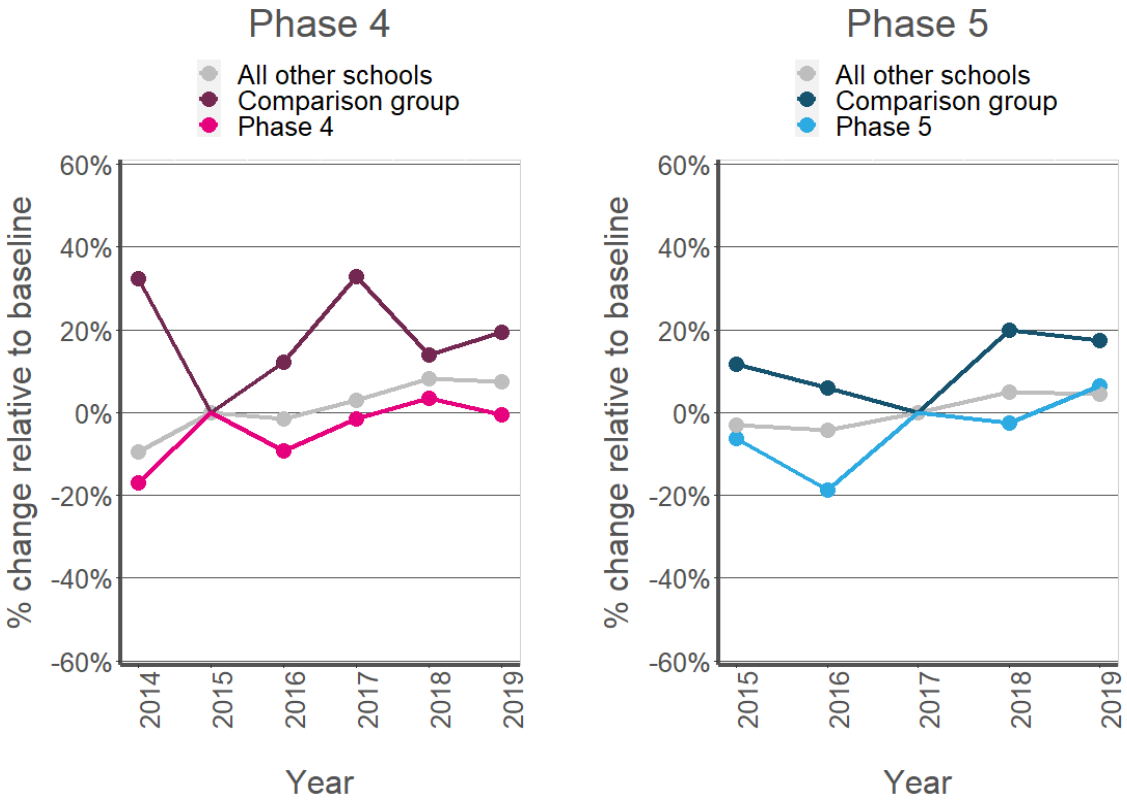


Figure 9b: Change in proportion of A-level physics students who were disadvantaged relative to baseline year



5.2.4 BAME pupils

In this section, we look at the increases in A-level numbers for pupils by ethnic group. Any pupils for whom data on ethnicity was not recorded in the National Pupil Database have been excluded from the analysis in this section.

Due to low numbers, some data in this section has been suppressed. This has been done to comply with requirements for using NPD data for research; counts lower than ten, or statistics based upon them, cannot be published. Years for which data is not available are left blank on the graphs below.

Table 6 shows the number of BAME pupils from SPN schools entering A-level physics. More detailed figures are available in the appendices, broken down by ethnic group using the following groups: Asian, Black, Chinese, mixed, white and other ethnic background.

Table 6: BAME pupils entering A-level physics from SPN schools

Phase 4

	2015	2016	2017	2018	2019
Number of pupils entering A-level physics for whom data on ethnicity is available	1362	1292	1429	1590	1509

	2015	2016	2017	2018	2019
Number of BAME pupils entering A-level physics	281	263	338	342	359
Number of white pupils entering A-level physics	1081	1029	1091	1248	1150
Total number of KS4 pupils for whom data on ethnicity is available	47216	46202	46166	45497	43266
% change in number of BAME pupils entering A-level physics from 2015	-	-6.4%	20.3%	21.7%	27.8%
% of BAME students	20.6%	20.4%	23.7%	21.5%	23.8%
% change in number of white pupils entering A-level physics from 2015	-	-4.8%	0.9%	15.4%	6.4%
Progression rate of BAME pupils		3.5%	3.2%	4.1%	4.0%

Phase 5

	2017	2018	2019
Number of pupils entering A-level physics for whom data on ethnicity is available	1588	1696	1747
Number of BAME pupils entering A-level physics	279	318	393
Number of white pupils entering A-level physics	1309	1378	1354
Total number of KS4 pupils for whom data on ethnicity is available	44514	43271	42334
% change in number of BAME pupils entering A-level physics from 2015	-	14.0%	40.9%
% of BAME students	17.6%	18.8%	22.5%
% change in number of white pupils entering A-level physics from 2015	-	5.3%	3.4%
Progression rate of BAME pupils	4.1%	4.5%	5.4%

More detailed information broken down by ethnic group is available in the appendices.

Figure 10a: Change in proportion of BAME students entering A-level physics relative to baseline year (excluding pupils for whom no data on ethnicity is available)

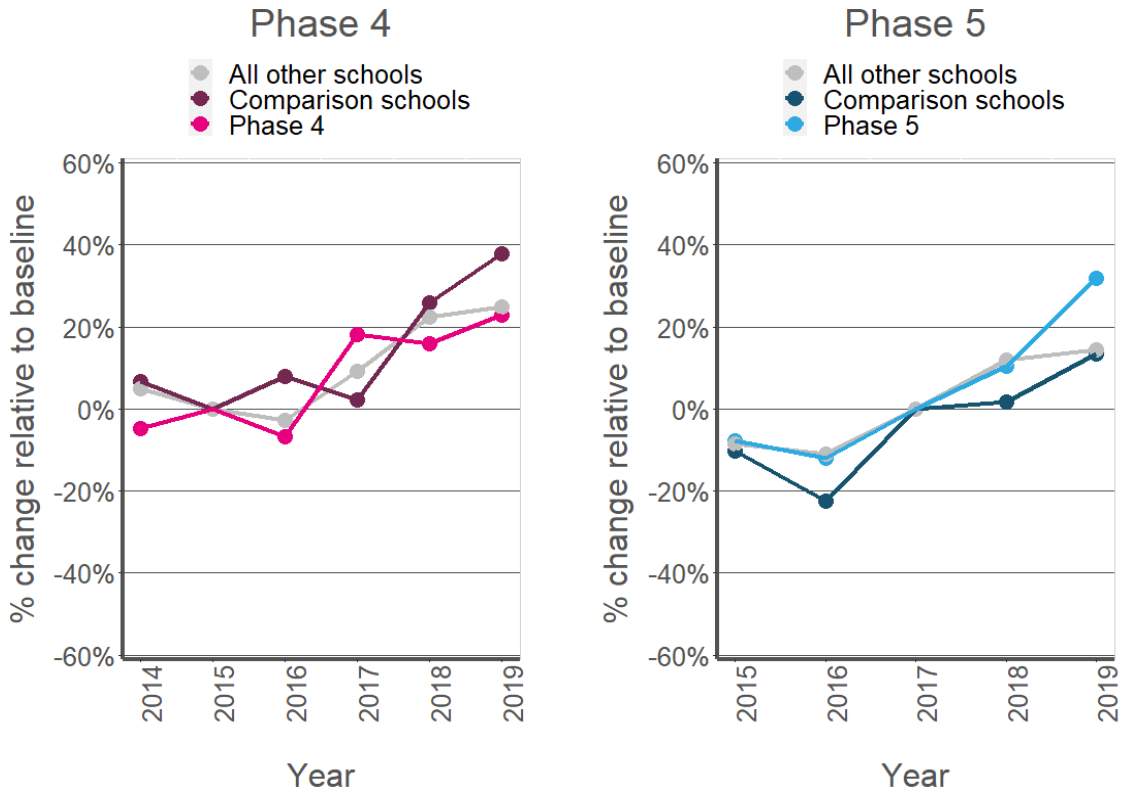
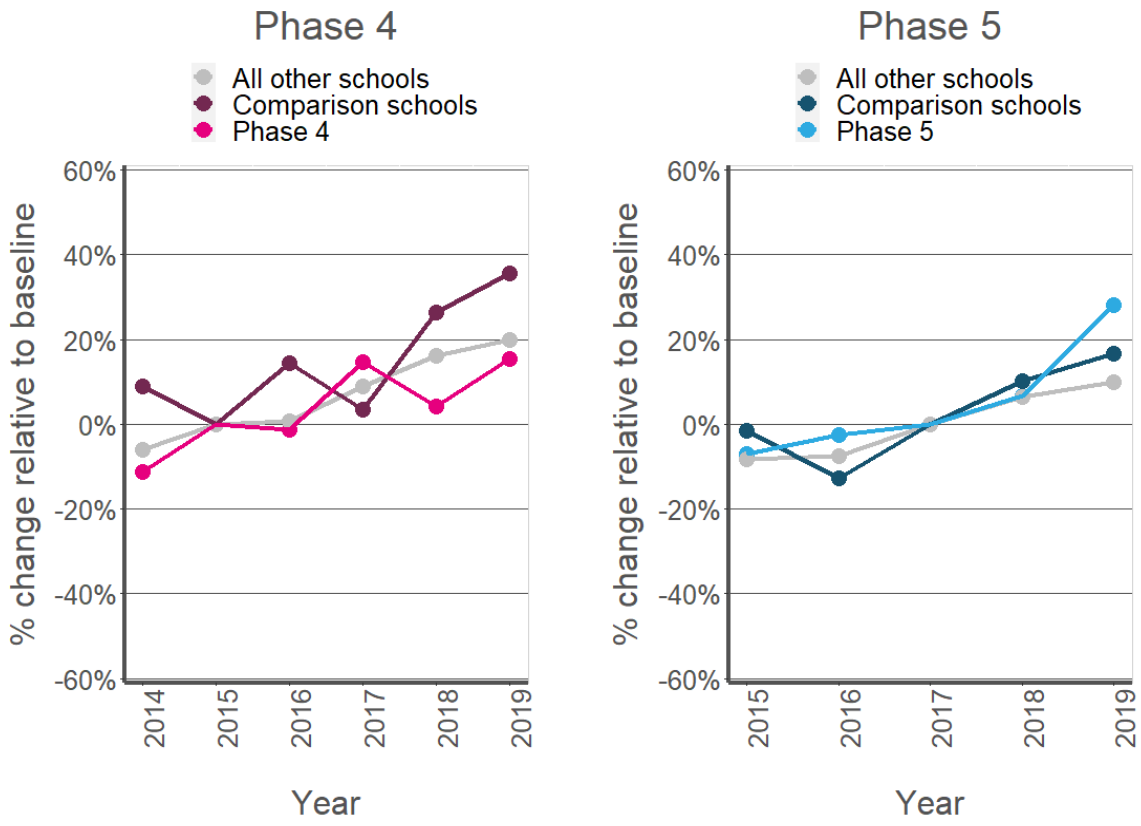


Figure 10b: Change in proportion of A-level physics students who were BAME relative to baseline year (excluding pupils for whom no data on ethnicity is available)



5.3 A-level grades

In this section, we compare the distribution of A-level grades in the year before each phase began to the year the phase ended. We begin by looking at grades for all students, and then look separately at students who took their A-levels at the same school in which they completed Key Stage 4, and students who transferred to a different institution to take A-levels.

In SPN Phase 4 schools, there was an increase in the number of students achieving the top A*/A grades during this period, from 313 in 2015, the year before the phase began to 388 in 2018. In Phase 5 schools, there was a small decrease, from 407 in 2017 to 395 students in 2019. However, these changes should be seen in the context of changes in the numbers entering A-level physics; this can be done by looking at the proportion of students achieving these grades.

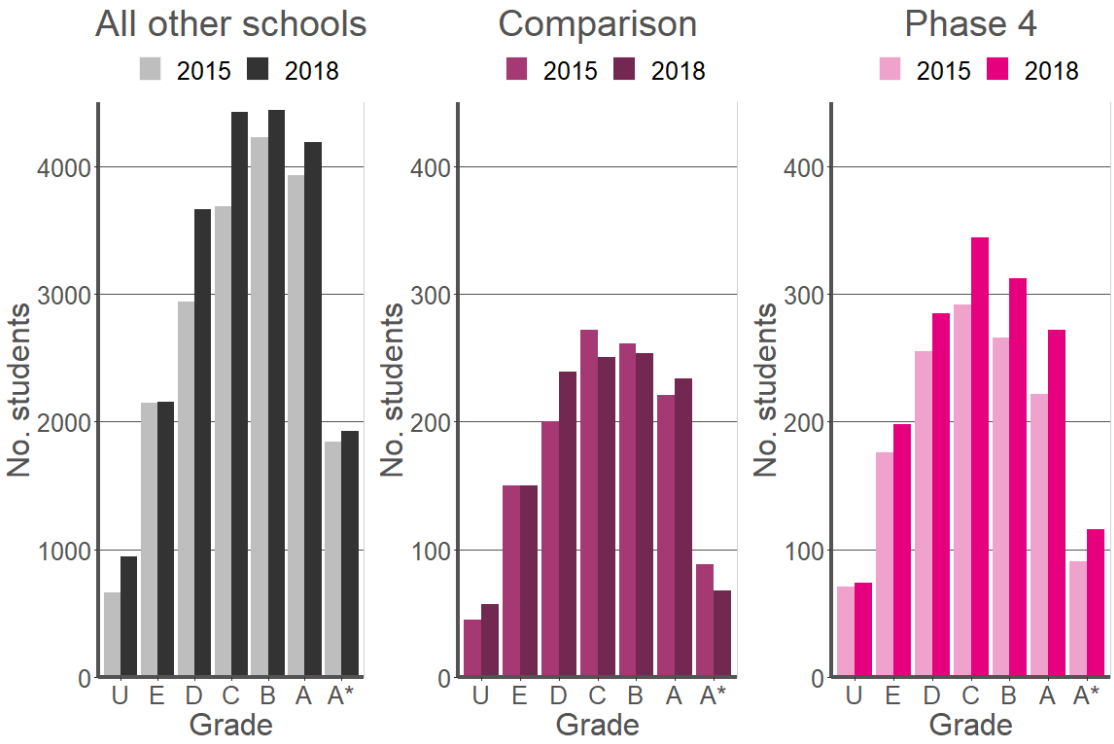
There was a fall in the proportion of students achieving the top grades during the period we are considering; this is perhaps not surprising considering the increase in number of entries. However, in SPN Phase 4 schools there was a small increase, from 22.8% in 2015 to 24.2% in 2018, while in matched comparison schools it fell from 25.0% to 24.1%, and from 29.7% to 28.2% in all other schools. In SPN Phase 5 schools the difference was less clear; the proportion achieving A*/A fell from 25.3% to 22.4%, while in matched comparison schools it fell from 27.9% to 23.2%, and in all other schools from 28.6% to 27.1%.

If we look separately at the grades of students who took their A-levels at the same school in which they completed Key Stage 4, and the grades of students who transferred to a different institution to take A-levels, we see some interesting patterns. Among pupils who continued at the same school, the number of pupils achieving the top A*/A grades in SPN Phase 4 schools increased from 135 in 2015 to 177 in 2018. Among pupils who transferred to a different institution, the number of pupils getting top grades in Phase 4 schools also increased, from 178 in 2015 to 211 in 2018. This is an increase in numbers of 31.1% for pupils who remained at their Phase 4 school, compared to 18.5% for pupils who did not. In comparison schools, there was a small decrease in the number of pupils who remained at the same school achieving the top grades, from 167 to 159, and for pupils who transferred it remained virtually the same, increasing from 142 to 143.

We see a similar pattern for Phase 5 schools. Although the numbers of students from Phase 5 schools achieving top grades decreased between 2017 and 2019, they decreased slightly less for those students who remained at their Phase 5 school for A-levels. Among pupils who remained at their Phase 5 school, the numbers achieving top A*/A grades fell from 221 in 2017 to 218 in 2019, and among pupils who transferred to another institution, they fell from 186 to 177 in the same period. This is a decrease of 1.4% among those who remained and 4.8% among those who transferred. In comparison schools, numbers fell from 182 to 176 among those who remained at their Key Stage 4 school, and from 134 to 92 among those who transferred.

Figure 11: Distribution of A-level phase grades, overall

Phase 4



Phase 5

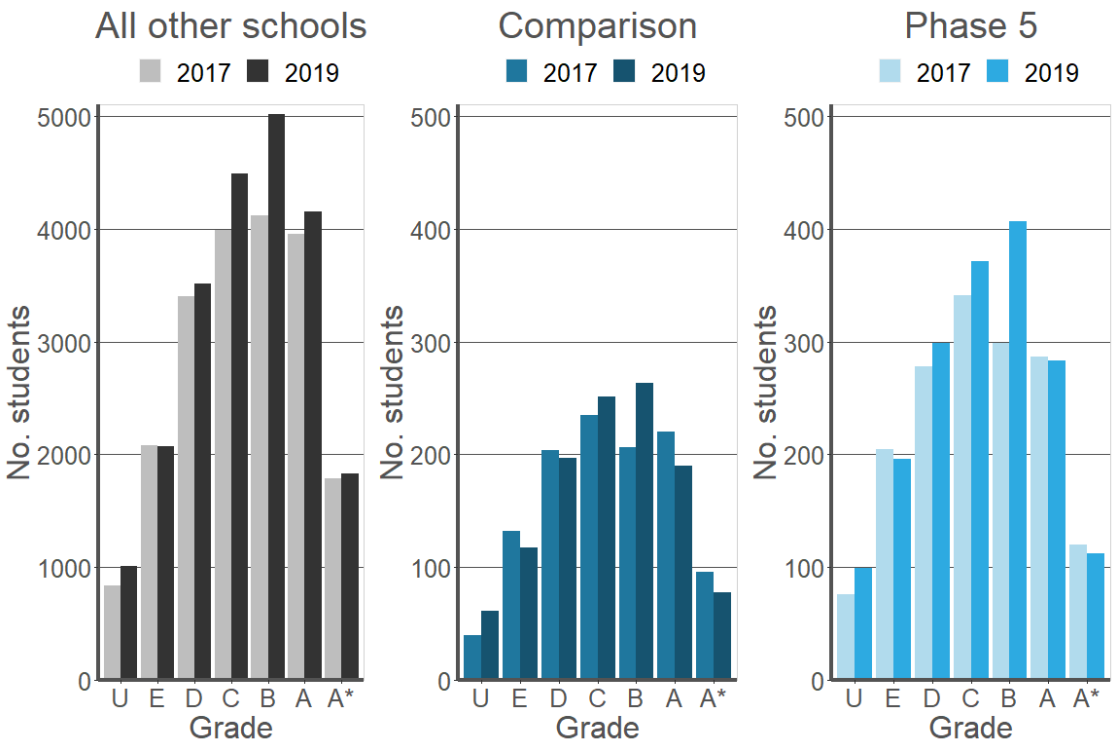
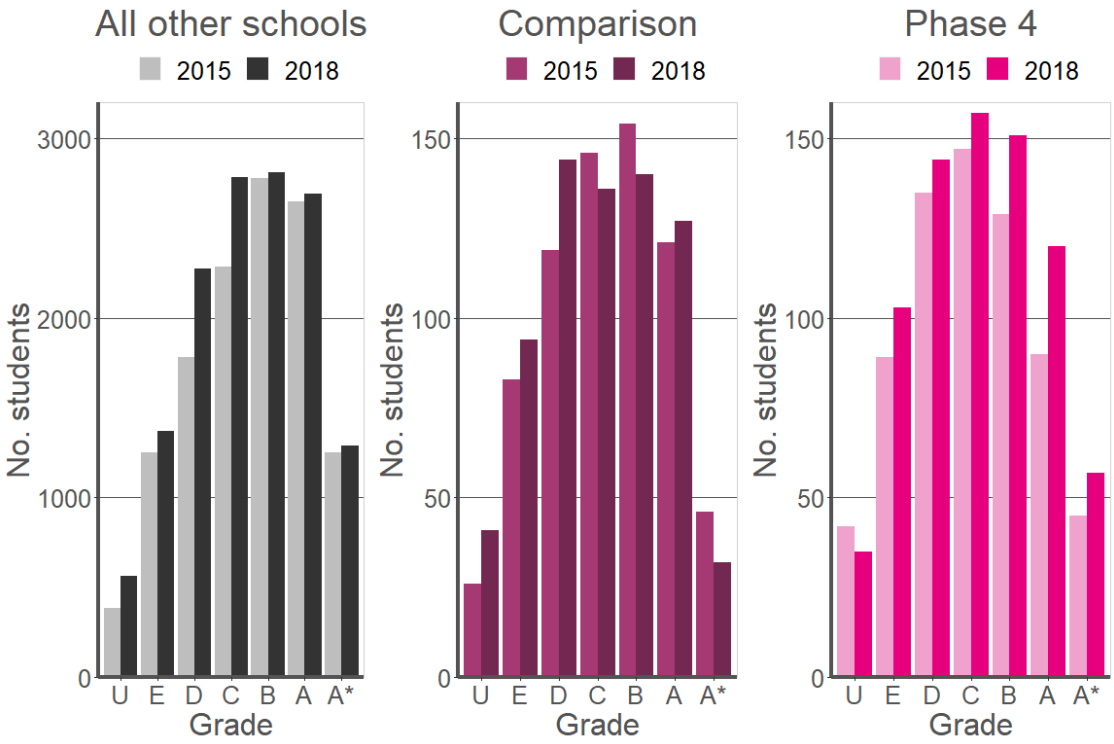


Figure 12: Distribution of A-level phase grades, pupils who continued at their Key Stage 4 school

Phase 4



Phase 5

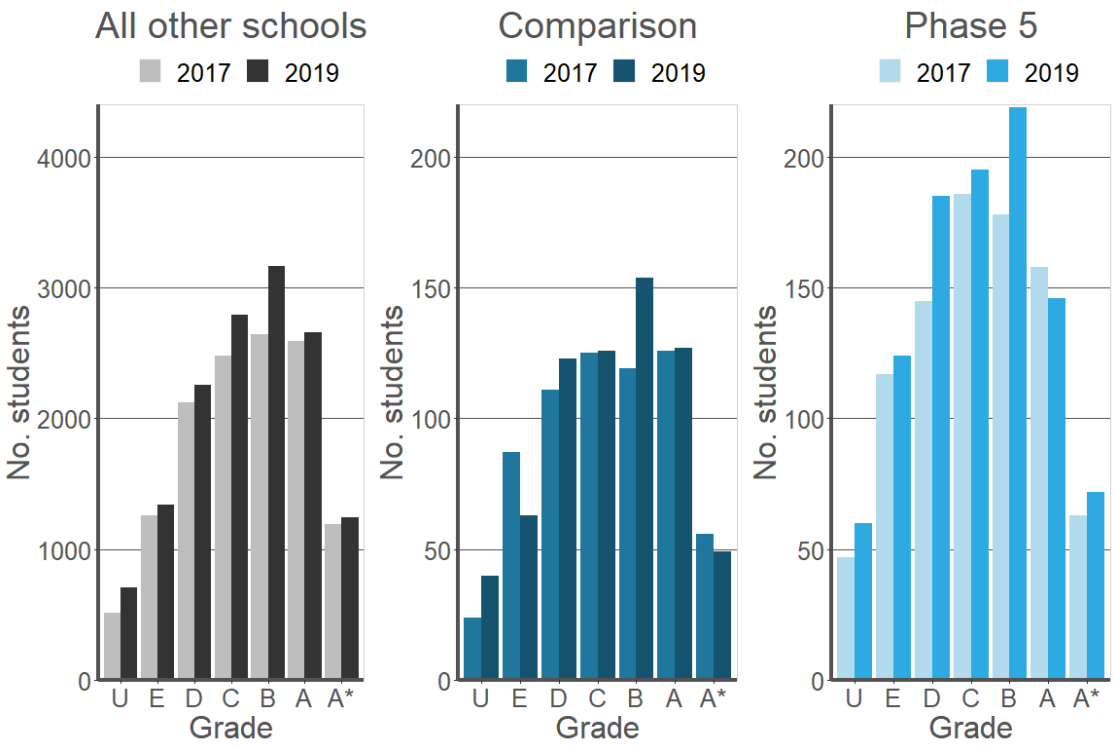
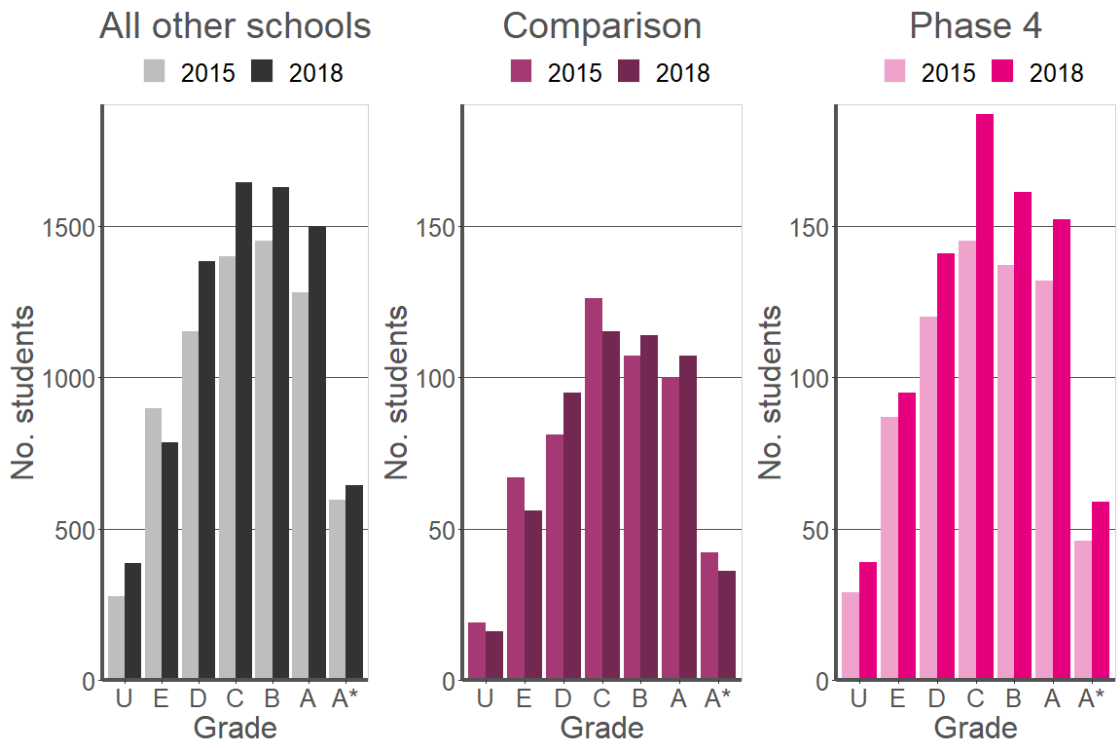
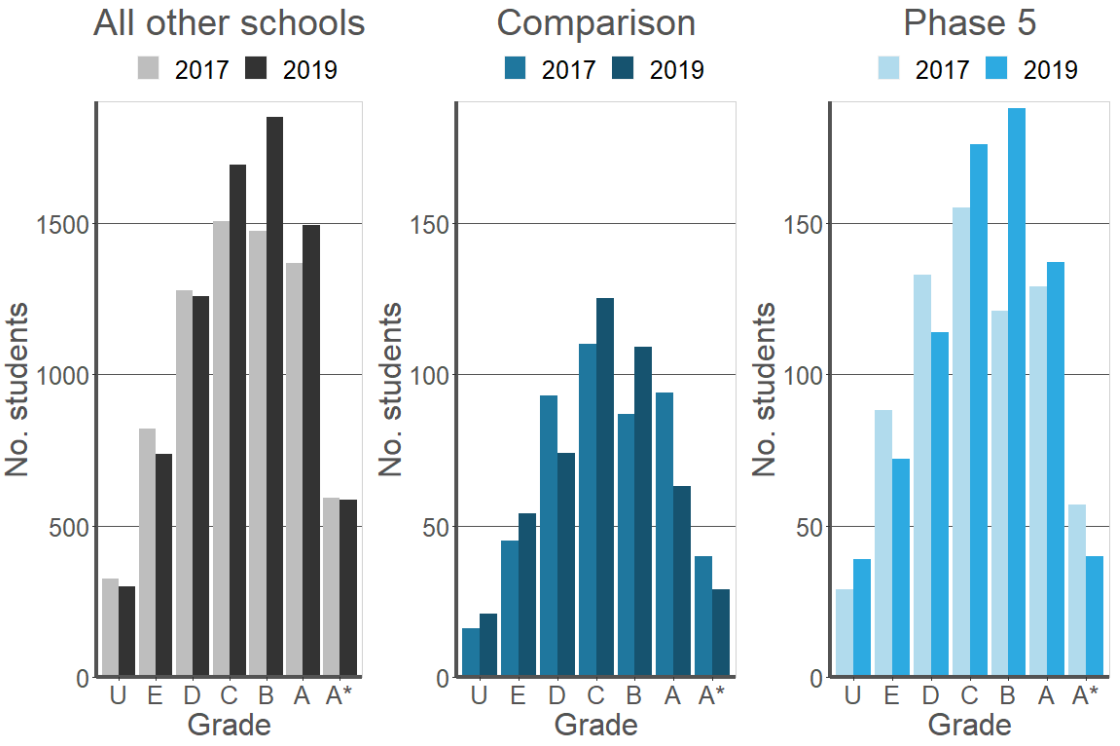


Figure 13: Distribution of A-level phase grades, pupils who transferred from their Key Stage 4 school

Phase 4



Phase 5



6 Results

This section presents estimates of the impact of SPN Phases 4 and 5 on the outcome measures, described as analysis c) in the methodology section. Estimates are presented along with 95% confidence intervals.

6.1 Formatting of results

Results are given in four different forms: estimated impact, effect size, months of progress and odds ratios.

Estimated impact is given in the same units as the outcome measure. In this report, it is used for the GCSE grade outcome measure. An estimated impact of one in 2019 would mean that we would expect a pupil at a treated school to achieve one grade higher than a pupil at a comparison school. However, this is complicated by changes to GCSE grading during the period covered by this report. Prior to 2018, GCSEs were graded A*-G. Although grades been converted to a notional nominal scale[4], the two grading systems are not directly equivalent.

Effect sizes are used here as a way to get around this problem and create estimates that can be compared across years. They also allow us to compare the magnitude of an effect across different outcome measures, such as GCSE grade and progression to A-level physics.

Effect sizes a standardised version of the estimated impact. That is, they are the estimated impact divided by the standard deviation in the outcome measure among all pupils. Because effect size a standardised measure, it can be compared across different outcomes; this means that it is a more helpful way of comparing the effect of the project on GCSE grades across the outcome years.

However, effect sizes can be difficult to interpret: it is not immediately obvious whether an effect size of, for example, 0.5 is large or small. Months of progress are a measure used in education research to try and help with this. In this report, effect sizes were translated into equivalent months of progress using guidance developed by the Education Endowment Foundation[5], as shown in table 7. In our example, an effect size of 0.5 would be the equivalent of six months of additional progress; expressed using the months of progress measure, it is clear that this is a large effect.

Table 7: Effect sizes and equivalent months of progress

Effect size from	To	Months of progress
-0.04	0.04	0
0.05	0.09	1
0.10	0.18	2

[4] This scale is A*=8.5; A=7; B=5.5; C=4; D=3; E=2; F=1.5; G=1

[5] As described at **https://educationendowmentfoundation.org.uk/projects-and-evaluation/evaluating-projects/evaluator-resources/writing-a-research-report**, accessed January 2020

Effect size from	To	Months of progress
0.19	0.26	3
0.27	0.35	4
0.36	0.44	5
0.45	0.52	6
0.53	0.61	7
0.62	0.69	8
0.70	0.78	9
0.79	0.87	10
0.88	0.95	11

Finally, odds ratios are used for reporting the estimated effect on progression and female progression. These ratios tell us the relative odds of a pupil progressing to complete an A-level in physics, depending on whether the student attended a treated school or a comparison school. An odds ratio of one would mean that a student from a treated school has exactly the same odds of progressing as a student from a comparison school. An odds ratio above one means that a student from a treated school is more likely to progress, and an odds ratio of below one means that they are less likely.

Odds ratios have been converted into effect sizes, then translated into months of progress using table 7. The conversion from odds ratio to effect size was done using the following formula:

$$effect\ size = \log(odds\ ratio) * \frac{\sqrt{3}}{\pi}$$

6.2 GCSE grades

GCSE grades are shown in this section as point scores, with a difference of one point being the equivalent of one grade. An estimated effect of 0.5, for example, would suggest that pupils in Phase 4 schools achieved the equivalent of half a grade more than pupils in comparison schools, after controlling for pupil demographics.

6.2.1 Phase 4

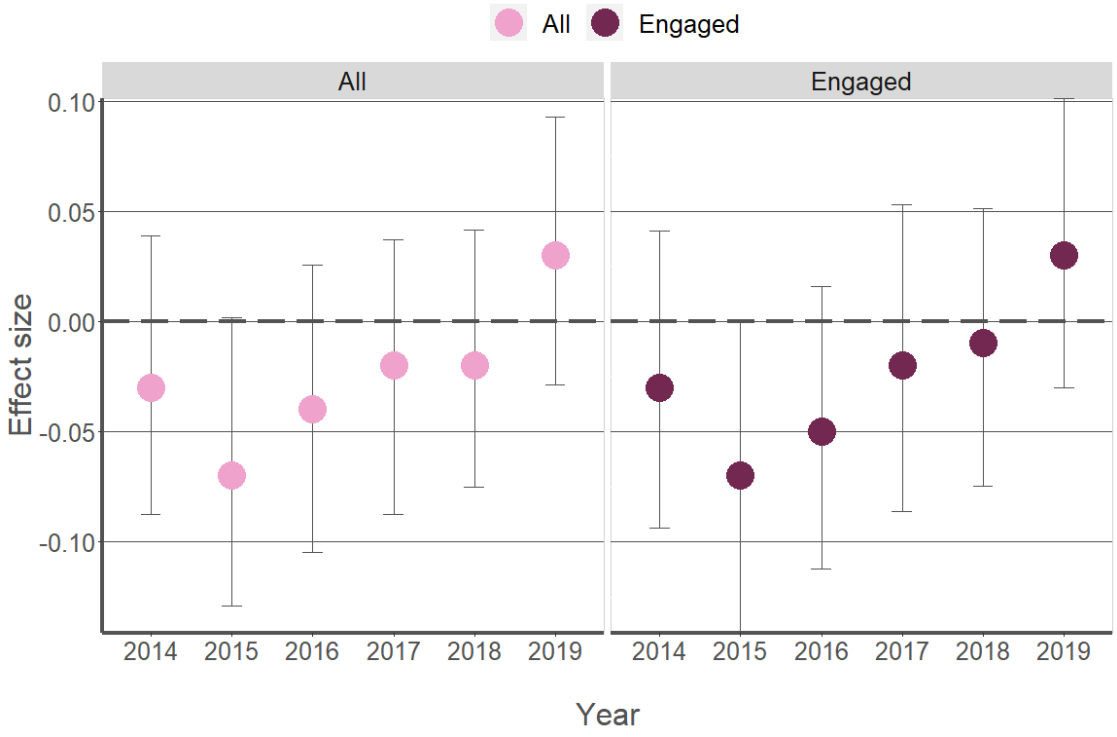
Estimates of the impact of SPN Phase 4 on attainment at GCSE physics are shown in table 8, with 95% confidence intervals (all to two decimal places). Results are also summarised in figure 14.

Table 8: Estimated effect of SPN Phase 4 on attainment at GCSE physics

Year	Group	Lower CI	Estimate	Upper CI	Effect size	Months prog
2014	All	-0.11	-0.03	0.05	-0.03	0
2015	All	-0.16	-0.08	0.00	-0.07	-1
2016	All	-0.13	-0.05	0.03	-0.04	0
2017	All	-0.15	-0.04	0.06	-0.02	0
2018	All	-0.14	-0.03	0.08	-0.02	0
2019	All	-0.06	0.06	0.18	0.03	0
2014	Engaged	-0.12	-0.03	0.05	-0.03	0
2015	Engaged	-0.17	-0.09	0.00	-0.07	-1
2016	Engaged	-0.14	-0.06	0.02	-0.05	-1
2017	Engaged	-0.15	-0.03	0.09	-0.02	0
2018	Engaged	-0.14	-0.02	0.10	-0.01	0
2019	Engaged	-0.06	0.07	0.19	0.03	0

These results do not provide any evidence that SPN Phase 4 had a positive effect on attainment in GCSE physics. For the majority of outcome years, both the overall estimates and those for engaged schools are slightly below zero, suggesting a small negative effect, but none are statistically significant; that is, all of the confidence intervals contain zero.

Figure 14: Estimated effect of SPN Phase 4 on attainment at GCSE physics



6.2.2 Phase 5

Estimates of the impact of SPN Phase 5 on attainment at GCSE physics are shown in table 9, with 95% confidence intervals (all to two decimal places). Results are summarised in figure 15.

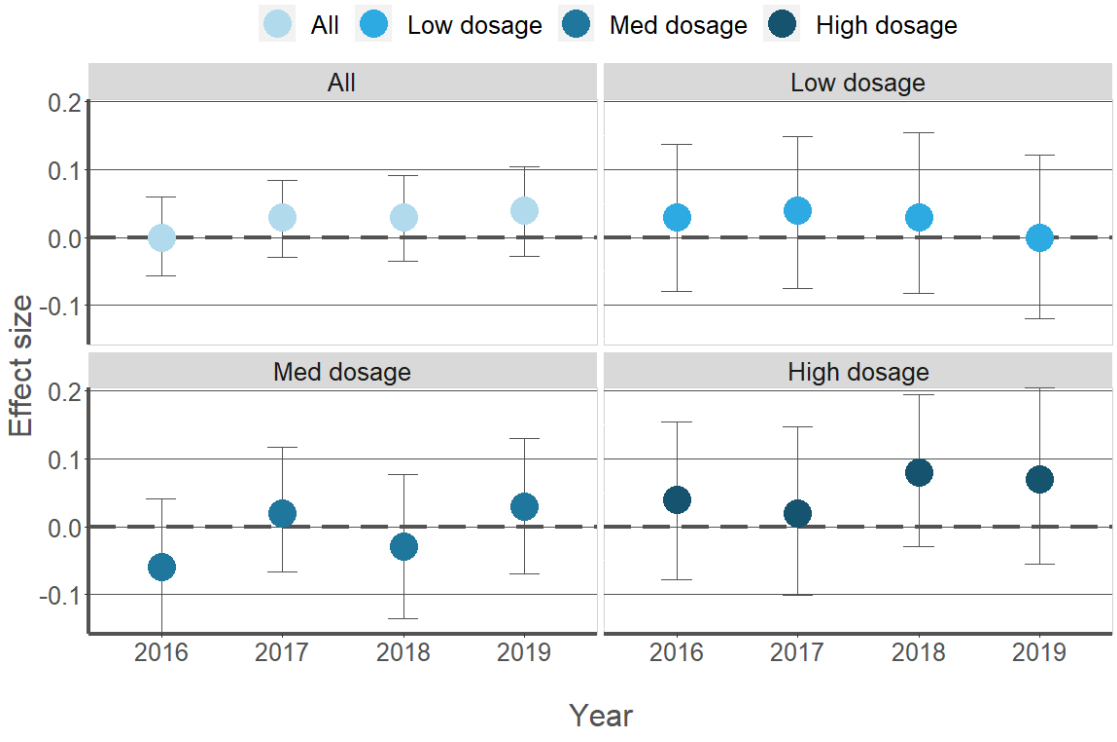
Table 9: Estimated effect of SPN Phase 5 on attainment at GCSE physics

Year	Group	Lower CI	Estimate	Upper CI	Effect size	Months prog
2016	All	-0.07	0.00	0.07	0.00	0
2017	All	-0.05	0.05	0.15	0.03	0
2018	All	-0.07	0.06	0.17	0.03	0
2019	All	-0.05	0.07	0.20	0.04	0
2016	Low dosage	-0.10	0.04	0.17	0.03	0
2017	Low dosage	-0.13	0.06	0.26	0.04	0
2018	Low dosage	-0.16	0.06	0.29	0.03	0
2019	Low dosage	-0.23	0.00	0.23	0.00	0
2016	Med dosage	-0.20	-0.07	0.05	-0.06	-1

Year	Group	Lower CI	Estimate	Upper CI	Effect size	Months prog
2017	Med dosage	-0.12	0.04	0.21	0.02	0
2018	Med dosage	-0.25	-0.05	0.15	-0.03	0
2019	Med dosage	-0.13	0.06	0.25	0.03	0
2016	High dosage	-0.10	0.05	0.19	0.04	0
2017	High dosage	-0.18	0.04	0.26	0.02	0
2018	High dosage	-0.06	0.15	0.37	0.08	1
2019	High dosage	-0.10	0.14	0.39	0.07	1

These results do not provide any conclusive evidence SPN Phase 5 had a positive effect on attainment in GCSE physics. The estimated overall effects are positive, if small, in every year, but none of the results are statistically significant - that is, all the confidence intervals include zero. The largest estimated impacts are on grades in 2018 and 2019; these are the equivalent of around a fifteenth of a grade. For the high dosage group, the estimated impact is higher, at just over a seventh of a grade in 2018 and 2019, but is still not statistically significant.

Figure 15: Estimated effect of SPN Phase 5 on attainment at GCSE physics



6.3 Progression to A-level physics

The outcome years shown in this section indicate the year in which pupils completed KS4. The most recent results available are for 2017: these are for pupils who completed KS4 in 2017 and who would have completed A-levels in 2019.

6.3.1 Phase 4

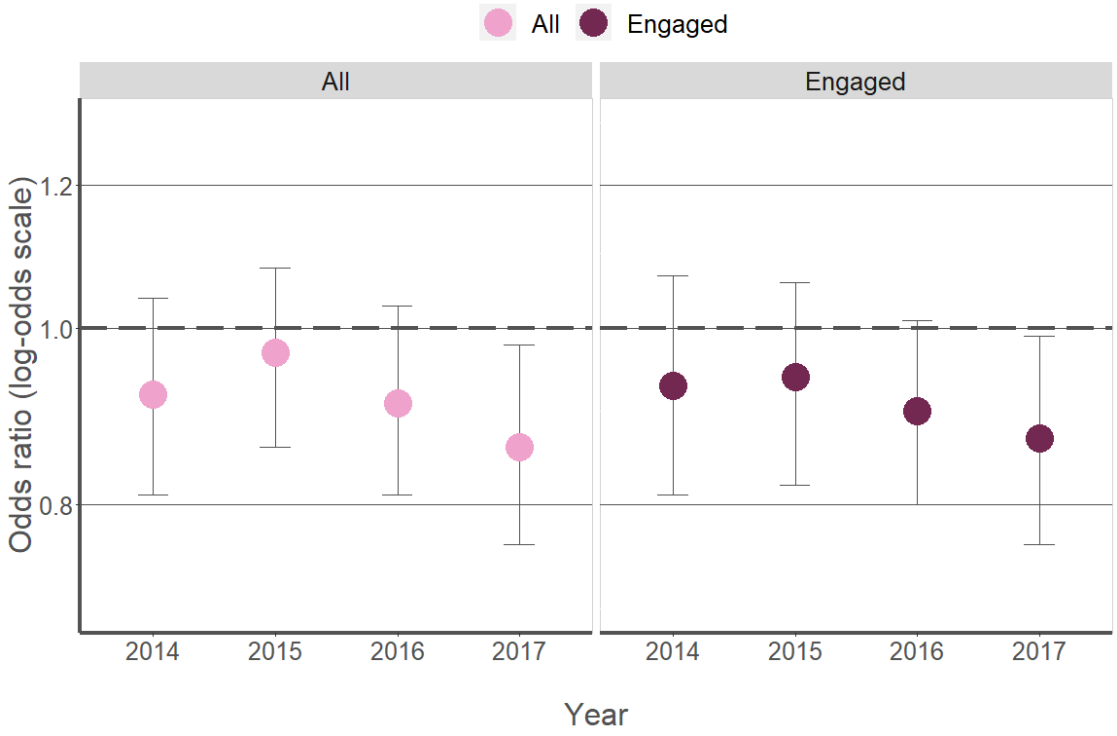
Estimates of the impact of SPN Phase 4 on the likelihood of pupils progressing to complete an A-level in physics are shown in table 10, with 95% confidence intervals (all to two decimal places). Results are also summarised in figure 16.

Table 10: Estimated effect of SPN Phase 4 on progression to A-level physics

Year	Group	Lower CI	Estimate	Upper CI	Effect size	Months prog
2014	All	0.81	0.92	1.04	-0.05	-1
2015	All	0.86	0.97	1.08	-0.02	0
2016	All	0.81	0.91	1.03	-0.05	-1
2017	All	0.76	0.86	0.98	-0.08	-1
2014	Engaged	0.81	0.93	1.07	-0.04	0
2015	Engaged	0.82	0.94	1.06	-0.04	0
2016	Engaged	0.80	0.90	1.01	-0.06	-1
2017	Engaged	0.76	0.87	0.99	-0.08	-1

These results do not provide evidence that SPN Phase 4 had a positive effect on the likelihood that a pupil would progress to complete an A-level in physics. For every outcome year, they suggest that pupils from SPN Phase 4 schools were slightly less likely to progress to study A-level physics than pupils from comparison schools, after controlling for differences in pupil characteristics. However, none of the results were statistically significant; that is, none of the confidence intervals contained one. This was the case overall and for engaged schools.

Figure 16: Estimated effect of SPN Phase 4 on progression to A-level physics



6.3.2 Phase 5

Estimates of the impact of SPN Phase 5 on the likelihood of pupils progressing to complete an A-level in physics are shown in table 11, with 95% confidence intervals (all to two decimal places). Results are also summarised in figure 17.

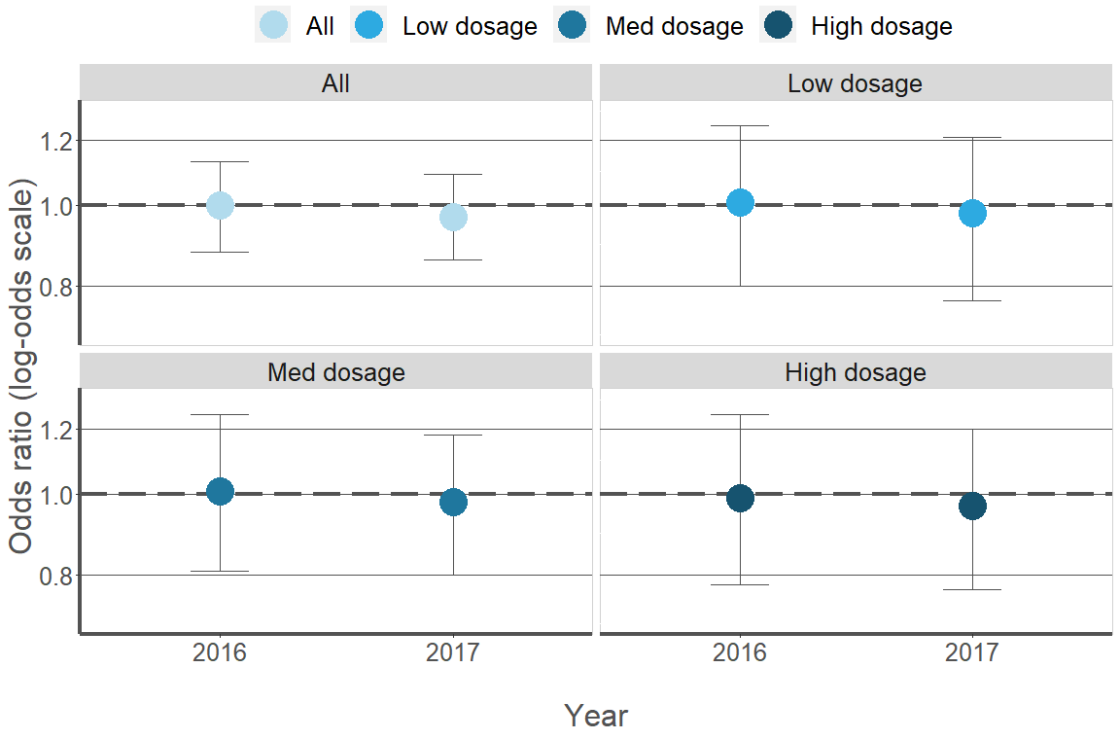
Table 11: Estimated effect of the IGB project on progression to A-level physics

Year	Group	Lower CI	Estimate	Upper CI	Effect size	Months prog
2016	All	0.88	1.00	1.13	0.00	0
2017	All	0.86	0.97	1.09	-0.02	0
2016	Low dosage	0.80	1.01	1.25	0.00	0
2017	Low dosage	0.77	0.98	1.21	-0.01	0
2016	Med dosage	0.81	1.01	1.25	0.01	0
2017	Med dosage	0.80	0.98	1.18	-0.01	0
2016	High dosage	0.78	0.99	1.25	0.00	0
2017	High dosage	0.77	0.97	1.20	-0.02	0

These results do not provide evidence that SPN Phase 5 had a positive effect on the likelihood that a pupil would progress to complete an A-level in physics. Pupils completing KS4 in 2016 were very slightly

more likely to go on to study A-level physics than pupils from comparison schools, after controlling for differences in pupil characteristics, but pupils completing KS4 in 2017 were slightly less likely. As both confidence intervals include one, neither result is statistically significant. The results were similar at all dosage levels.

Figure 17: Estimated effect of SPN Phase 5 on progression to A-level physics



6.4 Progression of female students to A-level physics

As above, the results in this section are expressed as odds ratios, and the outcome years shown in this section indicate the year in which pupils completed KS4.

6.4.1 Phase 4

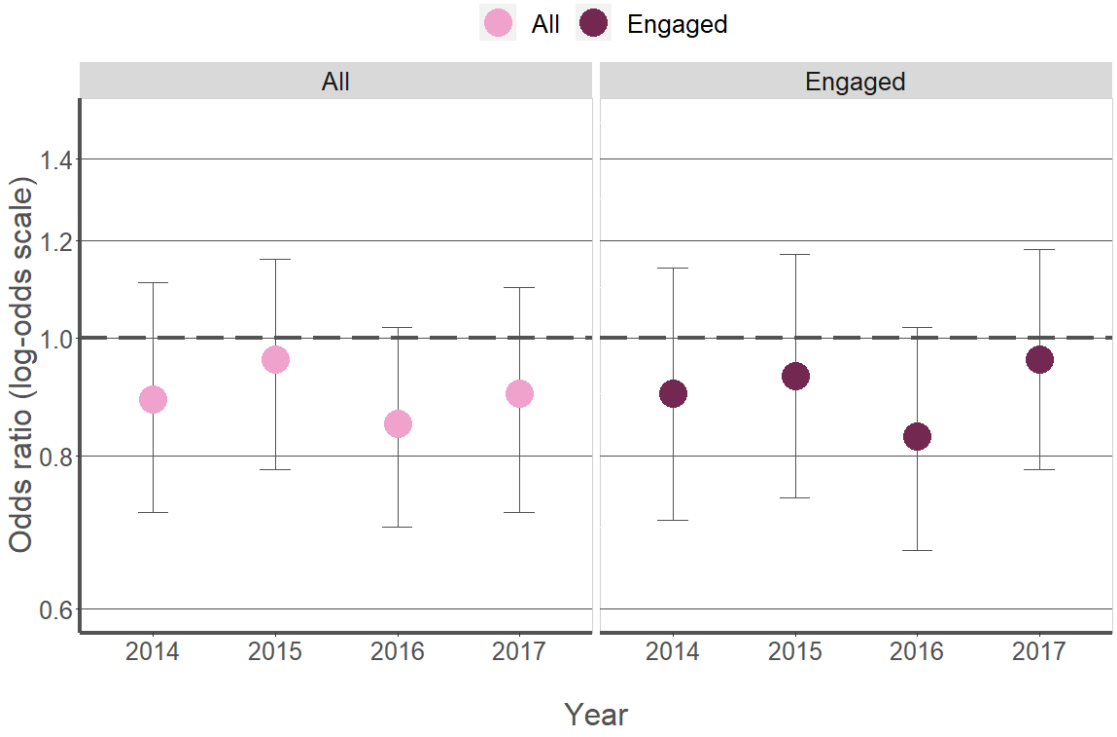
Estimates of the impact of SPN Phase 4 on the likelihood of female pupils progressing to complete an A-level in physics are shown in table 12, with 95% confidence intervals (all to two decimal places). Results are also summarised in figure 18.

Table 12: Estimated effect of SPN Phase 4 on female progression to A-level physics

Year	Group	Lower CI	Estimate	Upper CI	Effect size	Months prog
2014	All	0.72	0.89	1.11	-0.06	-1
2015	All	0.78	0.96	1.16	-0.02	0
2016	All	0.70	0.85	1.02	-0.09	-1
2017	All	0.72	0.90	1.10	-0.06	-1
2014	Engaged	0.71	0.90	1.14	-0.06	-1
2015	Engaged	0.74	0.93	1.17	-0.04	0
2016	Engaged	0.67	0.83	1.02	-0.10	-2
2017	Engaged	0.78	0.96	1.18	-0.02	0

These results do not provide evidence that SPN Phase 4 had a positive effect on the likelihood that a female pupil would progress to complete an A-level in physics. For every outcome year, they suggest that female pupils from SPN Phase 4 schools were slightly less likely to progress to study A-level physics than female pupils from comparison schools, after controlling for differences in pupil characteristics. However, none of the results is statistically significant; all the confidence intervals contain one. Results for engaged schools were similar to the overall results.

Figure 18: Estimated effect of SPN Phase 4 on female progression to A-level physics



6.3.2 Phase 5

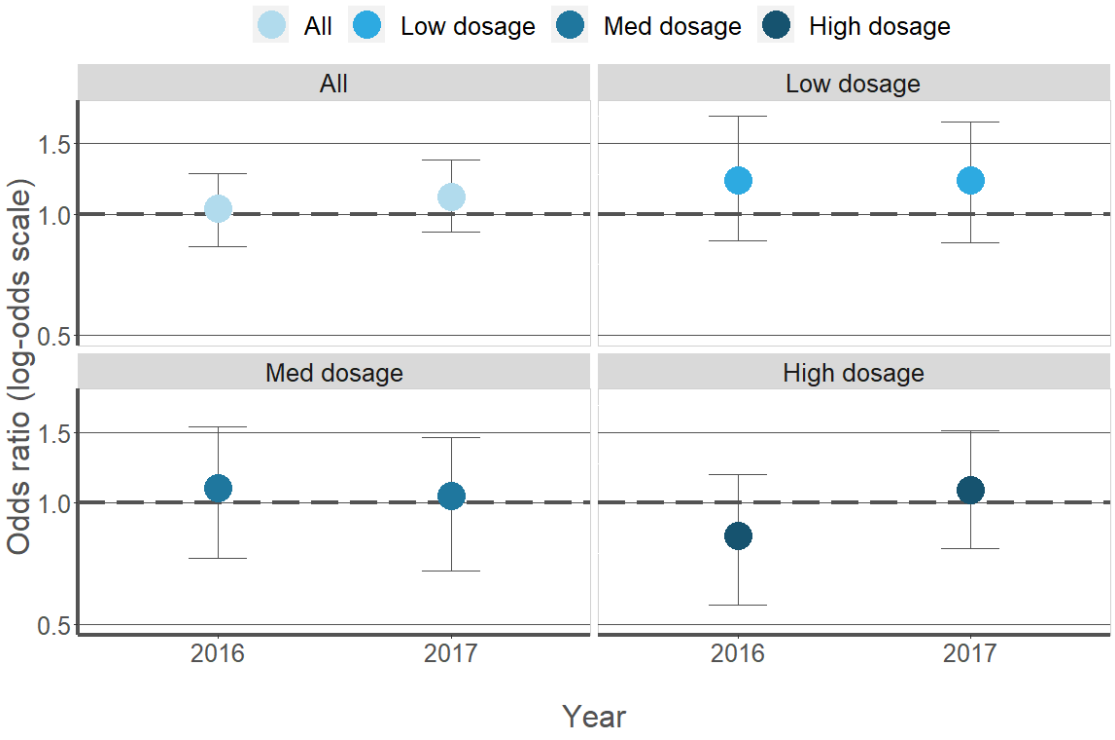
Estimates of the impact of SPN Phase 5 on the likelihood of female pupils progressing to complete an A-level in physics are shown in table 13, with 95% confidence intervals (all to two decimal places). Results are also summarised in figure 19.

Table 13: Estimated effect of SPN Phase 5 on female progression to A-level physics

Year	Group	Lower CI	Estimate	Upper CI	Effect size	Months prog
2016	All	0.83	1.03	1.26	0.02	0
2017	All	0.90	1.10	1.36	0.05	1
2016	Low dosage	0.86	1.21	1.75	0.11	2
2017	Low dosage	0.85	1.21	1.69	0.10	2
2016	Med dosage	0.73	1.09	1.55	0.05	1
2017	Med dosage	0.68	1.04	1.46	0.02	0
2016	High dosage	0.56	0.83	1.18	-0.11	-2
2017	High dosage	0.77	1.08	1.51	0.04	0

These results do not provide conclusive evidence that SPN Phase 5 had a positive effect on the likelihood that a female pupil would progress to complete an A-level in physics. Although most estimates are greater than one, suggesting that female pupils from SPN Phase 5 schools were more likely to progress to complete a physics A-level, none were statistically significant; all confidence intervals contain one. Rather surprisingly, the effect was strongest for low dosage schools.

Figure 19: Estimated effect of SPN Phase 5 on progression to A-level physics



6.5 A-level grades

As above, the results in this section are expressed as odds ratios, and the outcome years shown in this section indicate the year in which pupils completed KS4. Because of the relatively small numbers involved, results in this section are not broken down by dosage.

6.4.1 Phase 4

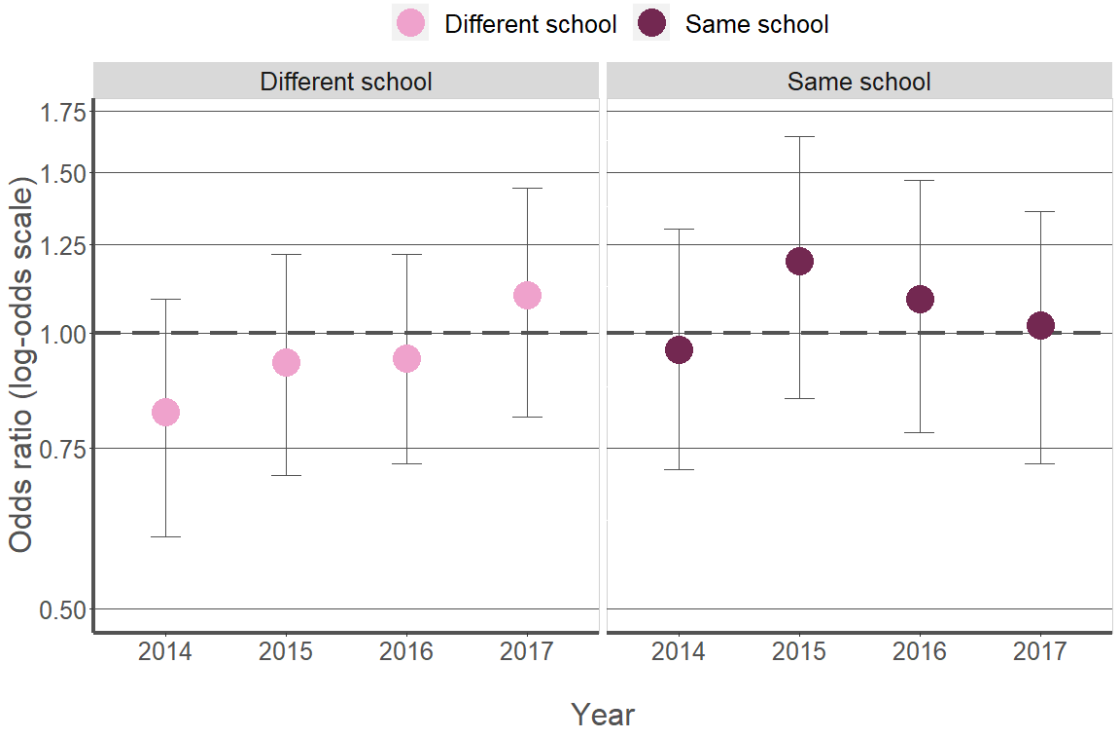
Estimates of the impact of SPN Phase 4 on the likelihood of achieving an A or A* in A-level physics are shown in table 14, for pupils who took their A-levels in the same school in which they completed KS4, and for pupils who took their A-levels at a different school. Estimates are shown with 95% confidence intervals (all to two decimal places). Results are also summarised in figure 20.

Table 14: Estimated effect of SPN Phase 4 on achieving an A/A* grade in A-level physics

Year	Group	Lower CI	Estimate	Upper CI	Effect size	Months prog
2014	Different school	0.60	0.82	1.09	-0.11	0
2015	Different school	0.70	0.93	1.22	-0.04	0
2016	Different school	0.72	0.94	1.22	-0.03	0
2017	Different school	0.81	1.10	1.44	0.05	1
2014	Same school	0.71	0.96	1.30	-0.02	0
2015	Same school	0.85	1.20	1.64	0.10	2
2016	Same school	0.78	1.09	1.47	0.05	1
2017	Same school	0.72	1.02	1.36	0.01	0

These results do not provide conclusive evidence that SPN Phase 4 had a positive effect on the likelihood achieving a top grade in A-level physics. None of the results were statistically significant; all confidence intervals contain one. However, the estimated impact on those students who took A-levels at the same school in which they completed KS4 is consistently higher than the estimated impact for those who took A-levels elsewhere, with the exception of 2017. For those who took A-levels in the same school, the estimate is highest in 2015 and then appears to tail off in 2016 and 2017.

Figure 20: Estimated effect of SPN Phase 4 on achieving an A/A* grade in A-level physics



6.4.2 Phase 5

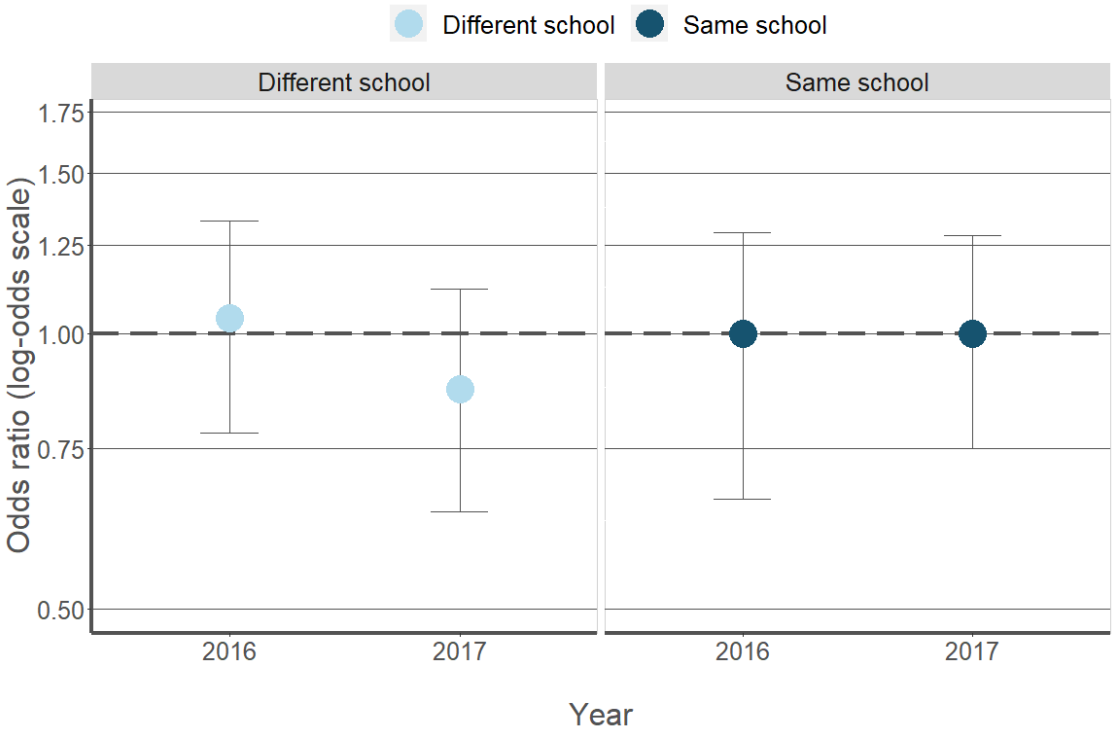
Estimates of the impact of SPN Phase 5 on the likelihood of achieving an A or A* in A-level physics are shown in table 15, for pupils who took their A-levels in the same school in which they completed KS4, and for pupils who took their A-levels at a different school. Estimates are shown with 95% confidence intervals (all to two decimal places). Results are also summarised in figure 21.

Table 15: Estimated effect of SPN Phase 5 on achieving an A/A* grade in A-level physics

Year	Group	Lower CI	Estimate	Upper CI	Effect size	Months prog
2016	Different school	0.78	1.04	1.33	0.02	0
2017	Different school	0.64	0.87	1.12	-0.07	0
2016	Same school	0.66	1.00	1.29	0.00	0
2017	Same school	0.75	1.00	1.28	0.00	0

These results do not provide conclusive evidence that SPN Phase 5 had a positive effect on the likelihood achieving a top grade in A-level physics. None of the results were statistically significant; all confidence intervals contain one, and the estimates for those who took their A-levels at the same school are not consistently higher than those for students who took their A-levels elsewhere.

Figure 21: Estimated effect of SPN Phase 5 on achieving an A/A* grade in A-level physics



7 Conclusions

7.1 Overview

Analysis a) found a relative increase in A-level physics entries from the baseline year in Phase 4 schools, but a relative decrease in Phase 5 schools, compared to all other schools. In 2018, A-level physics entries from students in Phase 4 schools were 17.4% higher than in the 2015 baseline year, compared to 11.6% higher in all other schools. Entries from students in Phase 5 schools were 7.8% higher in 2019 than in the 2017 baseline year for this phase, compared to 9.6% in all other schools. There were greater differences when entries were broken down by gender. In 2018, entries from female students in Phase 4 schools were 29.2% higher than the baseline year, while in other schools they were just 13.0% higher. In Phase 5 schools, entries in 2019 were 19.7% higher than the 2017 baseline figure, compared to just 14.8% for all other schools. This was balanced by smaller relative increases in entries for male students.

In analysis b), which used a reduced dataset excluding schools that had taken part in an earlier phase of the project, and compared results to a matched group of comparison schools rather than to all other schools, we found a relative increase in A-level physics entries in SPN schools. In 2018, entry numbers in Phase 4 schools were 16.6% higher than in the baseline year, compared to 1.3% in the matched comparison group. In Phase 5 schools, entries in 2019 were 10.0% higher relative to the baseline year, compared to 2.1% in matched comparison schools. However, when we looked at the proportion of the cohort entering A-level physics, rather than at total numbers, the differences between SPN schools and comparison schools were not so clear; SPN schools also had a relative increase in the number of KS4 pupils.

Analysis b) also found a relative increase of the number of pupils achieving the top A*/A grades in A-level physics SPN schools. Among pupils who took their A-level at the same school in which they completed KS4, the number of pupils achieving the top grades in Phase 4 schools in 2018 was 31.1% higher than the baseline year, while in comparison schools it was 4.8% lower. In Phase 5 schools, the number achieving top grades in in 2019 was 1.4% lower than in the baseline year, while in comparison schools is was 3.3% lower. These relative increases were not seen to the same extent among pupils who went on to take A-levels at a different institution.

Analysis c) did not find conclusive evidence to show that either SPN Phase 4 or SPN Phase 5 had a statistically significant positive effect on GCSE physics grade, progression to A-level physics, female progression to A-level physics or on the likelihood of achieving a top grade in A-level physics. However, we did find a small positive effect on the likelihood of female pupils progressing to complete an A-level in physics in SPN Phase 5 schools, and on the likelihood of achieving top A-level grades for those Phase 4 pupils who took their A-levels at the same school in which they completed KS4. These effects were not statistically significant, but, taken with the findings from analyses a) and b), they do provide an indication that SPN may have had a positive impact on these two outcomes.

Generally, we found little difference by dosage. This may indicate that, as discussed in section 7.2 below, the measure of dosage used was not reliable. However, we did find that the effect on GCSE grade was higher for high dosage Phase 5 schools than other schools, up to just over a seventh of a grade. For Phase 4, we found little difference between estimates made using all Phase 4 schools, and those made using engaged schools only.

7.2 Limitations

Analysis b) and c) compare SPN schools to a matched comparison group created using observational data from the National Pupil Database (NPD). This type of evaluation is known as a quasi-experimental design. However, ideally, from an evaluation perspective, the project would have been provided to schools as part of a randomised control trial (RCT). We would therefore be tentative in asserting that the results of this evaluation represent the true size of the projects' impact for the reasons outlined below. The ideal evaluation of the project would have come from a fully randomised control trial which would allow for isolation of project participation as a lone variable of interest. As this was not the case, the results represent the best estimate of the effectiveness of participation in the project that we were able to provide.

With a quasi-experimental design, there are a number of possible problems. In our analysis, we had to rely on the data in the NPD, but the NPD data is limited. For example, it does not include information about social class, parental occupations or school funding levels. Not accounting for these unobserved variables may introduce bias into our estimates. Using a quasi-experimental design also leaves open the question of how schools were selected to join the project. The SPN project targeted schools in need of support with physics teaching, particularly those with few or no specialist physics teachers. Recruitment was done by a team based around the country often using local knowledge to identify suitable schools.

We had no way of replicating this selection process using data, and this may have led to underestimation of effects, if our comparison group included schools that would not have been deemed to be in need of support. A number of SPN schools also took part in earlier phases of the project. We excluded these schools from the bulk of the analysis, considerably reducing the sample size. It's possible that this led to an underestimation of effects if these schools benefited particularly from the intervention.

The dosage data provided was an imperfect measure of how much schools had engaged. For Phase 4, we had only a rough indication of whether schools engaged with the project or not, but no information on the degree of engagement. For Phase 5, the measure used was 'teacher hours', which is simply calculated by multiplying the number of teachers who took part in a session by the number of hours the session lasted. This may mean that schools with more teachers are over-represented in the high dosage group, or that smaller schools may be deemed to be less engaged than others. This could lead to misleading estimates.

Some comparison schools may have taken part in similar projects, or teachers from those schools may have attended training similar to that offered by the projects. If this was the case, our analysis would not be an evaluation of the project against no equivalent support, but instead against no support in some cases and other, similar support in the rest. This could lead us to underestimate the effect of the projects, assuming that the equivalent support had a positive effect on some comparison schools' outcomes. We would note, however, that not controlling for this effect may be the relevant analysis as it represents an evaluation of the project against current conditions, with schools' choices to engage with other projects or training being included in the makeup of controls.

In addition, analysis b) does not control for the uncertainty inherent in the matching process or for changes in pupil characteristics. Analysis a) does not use a matched comparison group at all, simply comparing SPN schools to all other school. This approach does not control for differences between SPN schools and other schools before the project began, and may lead to either over- or under-estimation of the impact.

Finally, analysis a) and b) look at changes relative to a baseline year. For Phase 4, outcomes in 2018, four years after the intervention began, are compared to the baseline. For Phase 5, outcomes in 2019, just three years after the invention began, are compared to the baseline. This is because more recent data is not yet available. This could lead to underestimation of effects for Phase 5 if effects become stronger over time.

8 Appendices

The 'Phase 4 Appendix - Summary statistics.xlxs' and 'Phase 5 Appendix - Summary statistics.xlxs' Excel workbooks include background data on how SPN schools compare to other state-funded mainstream schools in England.

Data from three years before the relevant phase began up until the most recent year for which data is available is provided on the following:

- Outcome measures:
    a. GCSE physics grade
    b. Progression to A-level physics
    c. Female progression to A-level physics
- Progression and female progression to Closing Doors subjects (Biology, Chemistry, English, Psychology and Economics)
- FSM6 progression to A-level physics
- Progression to A-level physics by ethnic group

Section 8.1 below includes a more detailed version of the analysis of A-level physics entries from BAME students presented in section 5.2.4.

8.1 Appendix: Pupils by ethnic group

This section follows on from section 5.2.4, and gives more detailed information on the A-level entries numbers in SPN schools by ethnic group using the following groups: Asian, Black, Chinese, mixed, white and other ethnic background.

Figure 22 shows the percentage increase in A-level numbers by ethnic group. In Phase 4 schools, there was either an increase or no change in the number of pupils taking A-level physics in every ethnic group, from 2015, the year before the phase began, to 2018.

Phase 4

In some cases, this increase was higher than the increase in comparison schools from 2015 to 2018. The number of Asian pupils increased by 32.6% in Phase 4 schools compared to just 25.5% in comparison schools, for pupils from a Chinese background there was an increase of 10.0% in Phase 4 schools compared to a 23.1% decrease in comparison schools. The number of white pupils taking A-level physics increased by 15.4% compared to a 4.1% decrease in comparison schools, and for pupils from other ethnic backgrounds there was an increase of 75.0% in Phase 4 schools compared to 13.3% in comparison schools.

However, the number of Black pupils increased by 9.1% in Phase 4 schools while there was a 62.1% increase in comparison schools. The number of pupils with mixed ethnicity remained the same in Phase 4 schools, while in comparison schools it increased by 29.8%.

Phase 5

In Phase 5 schools, there was an increase in the number of pupils taking A-level physics in every ethnic group except students from a Chinese background, from 2017, the year before the phase began, to 2019. This is shown in figure 22b.

As for Phase 4 schools, the number of Asian pupils taking physics increased by more than in comparison schools: it increased by 61.5% compared to 21.4% in comparison schools. However, unlike Phase 4 schools, there was a 10.0% decrease in the number of pupils from a Chinese background taking A-level physics; figures for comparison schools are unavailable for this group due to low numbers. The number of white students taking A-level physics increased by 3.4% in Phase 5 schools but fell but 1.9% in comparison schools, and the number of pupils from other ethnic backgrounds increased by 48.0% in Phase 5 schools; figures for comparison schools are unavailable for this group due to low numbers.

In Phase 5 schools, the numbers of Black students taking physics increased more than in comparison schools, by 24.4% compared to 7.4% for comparison schools. The number of Phase 5 students from a mixed ethnic background taking A-level physics increased by 22.2% between 2017 and 2019, while in comparison schools it increased by just 10.8%.

Figure 22a: Change in A-level entries from Phase 4 schools relative to baseline year, by ethnic group

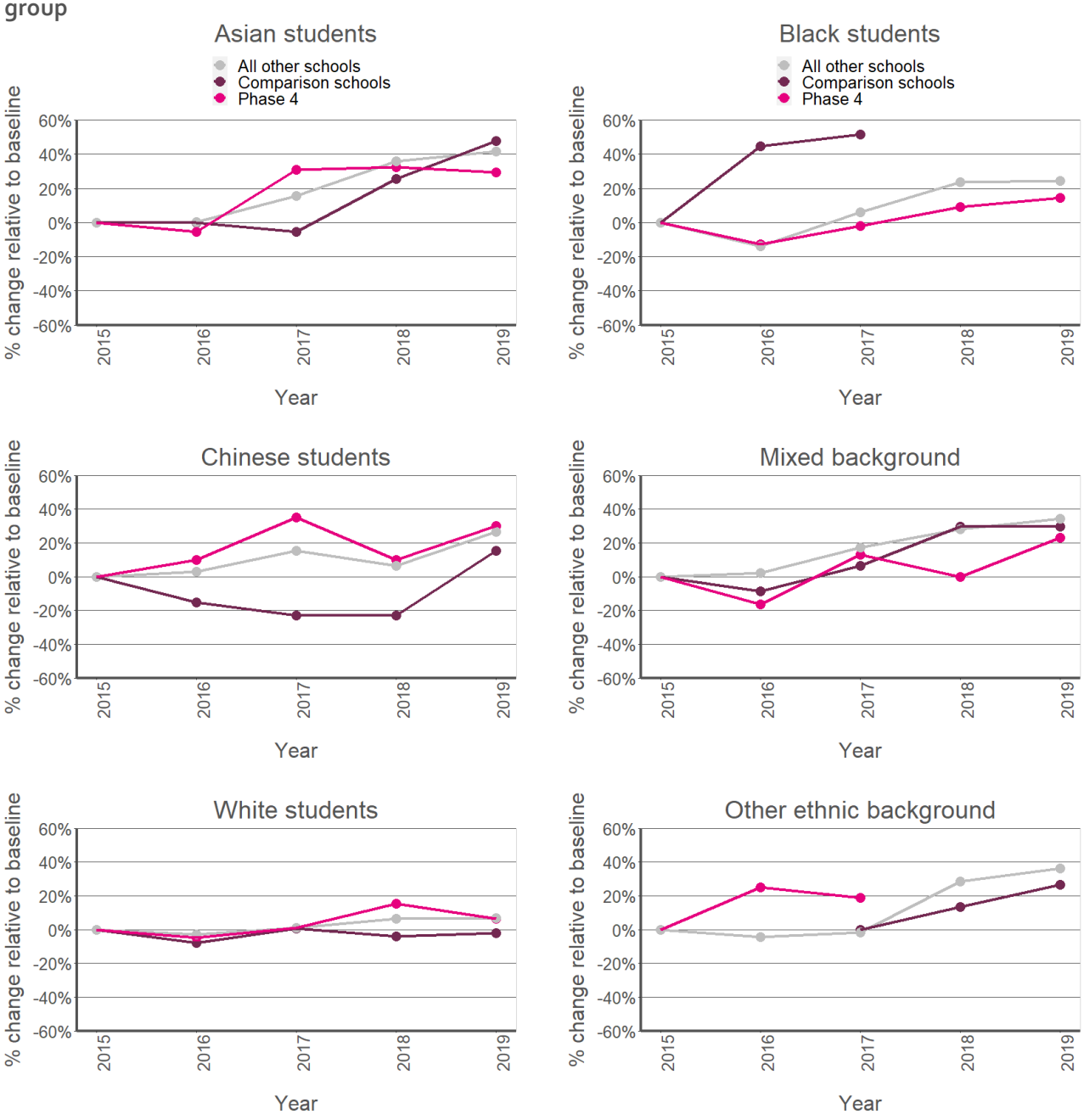
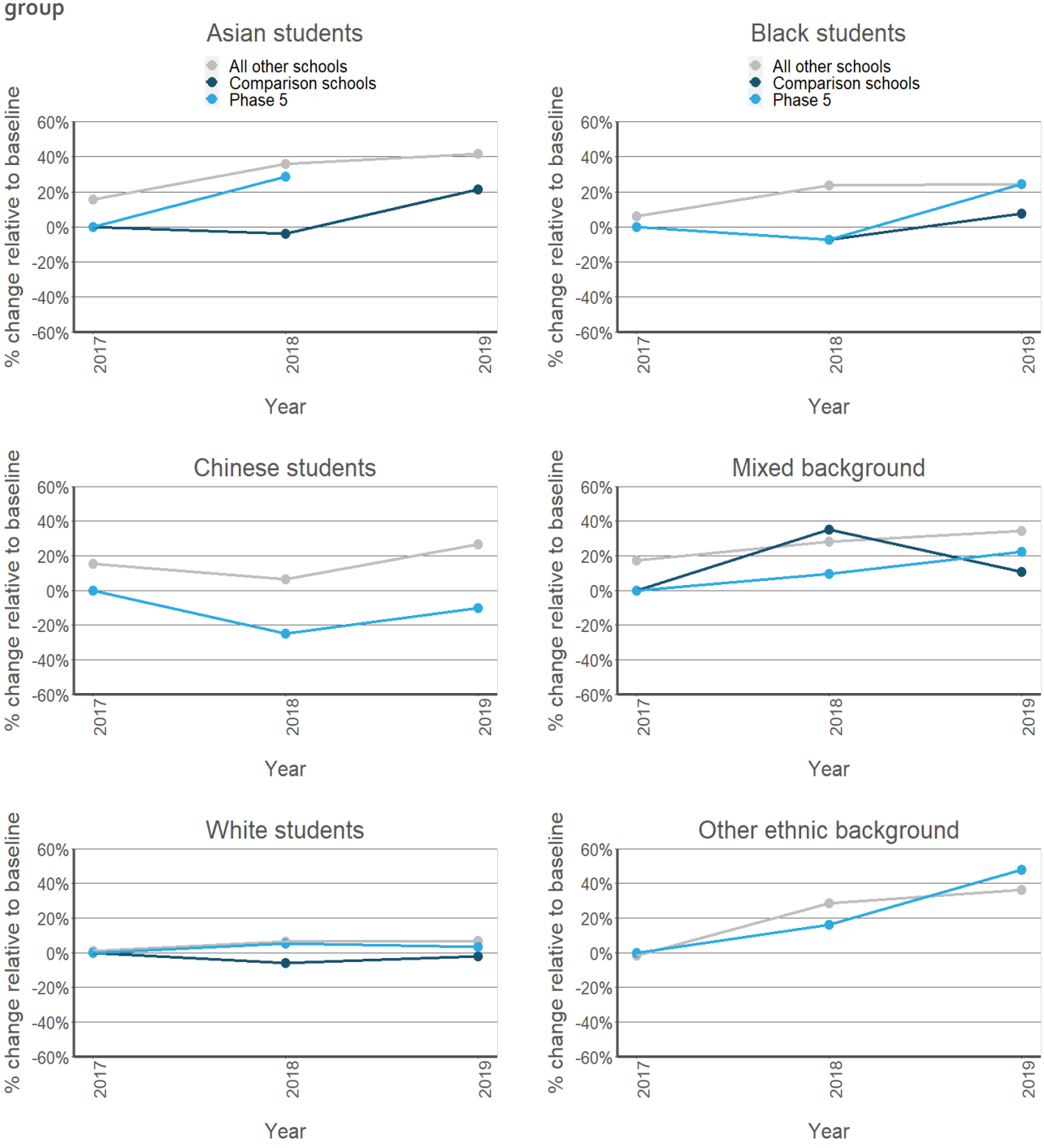


Figure 22b: Change in A-level entries from Phase 5 schools relative to baseline year, by ethnic group



These figures should be interpreted with caution. The use of percentage increases can exaggerate differences when small numbers are involved. For example, the number of pupils from a Chinese background increased by 10.0% in Phase 4 schools between 2015 and 2018, and decreased by 23.1% in comparison schools. This sounds like a large difference, but it actually represents small changes in the numbers that could well be due to chance. The 10.0% increase in Phase 4 schools represents an increase of just two pupils; from 20 in 2015 to 22 in 2018, and the 23.1% decrease in comparison schools represents a decrease of three pupils, from thirteen in 2015 to ten in 2018.

It is also important to note that the profile of students in both SPN schools and comparison schools would have changed during the course of each phase, and this will have affected the numbers. For example, the number of Phase 5 students from a mixed ethnic background taking A-level physics increased by 22.2% between 2017 and 2019, while in comparison schools it increased by just 10.8%. However, during the same period the overall number of students from a mixed ethnic background in Phase 5 schools increased by 4.2%, while in comparison schools it fell by 10.2%.

For these reasons, it is useful to consider the proportion of BAME pupils who go on to enter A-level physics, as shown in section 5.2.4.