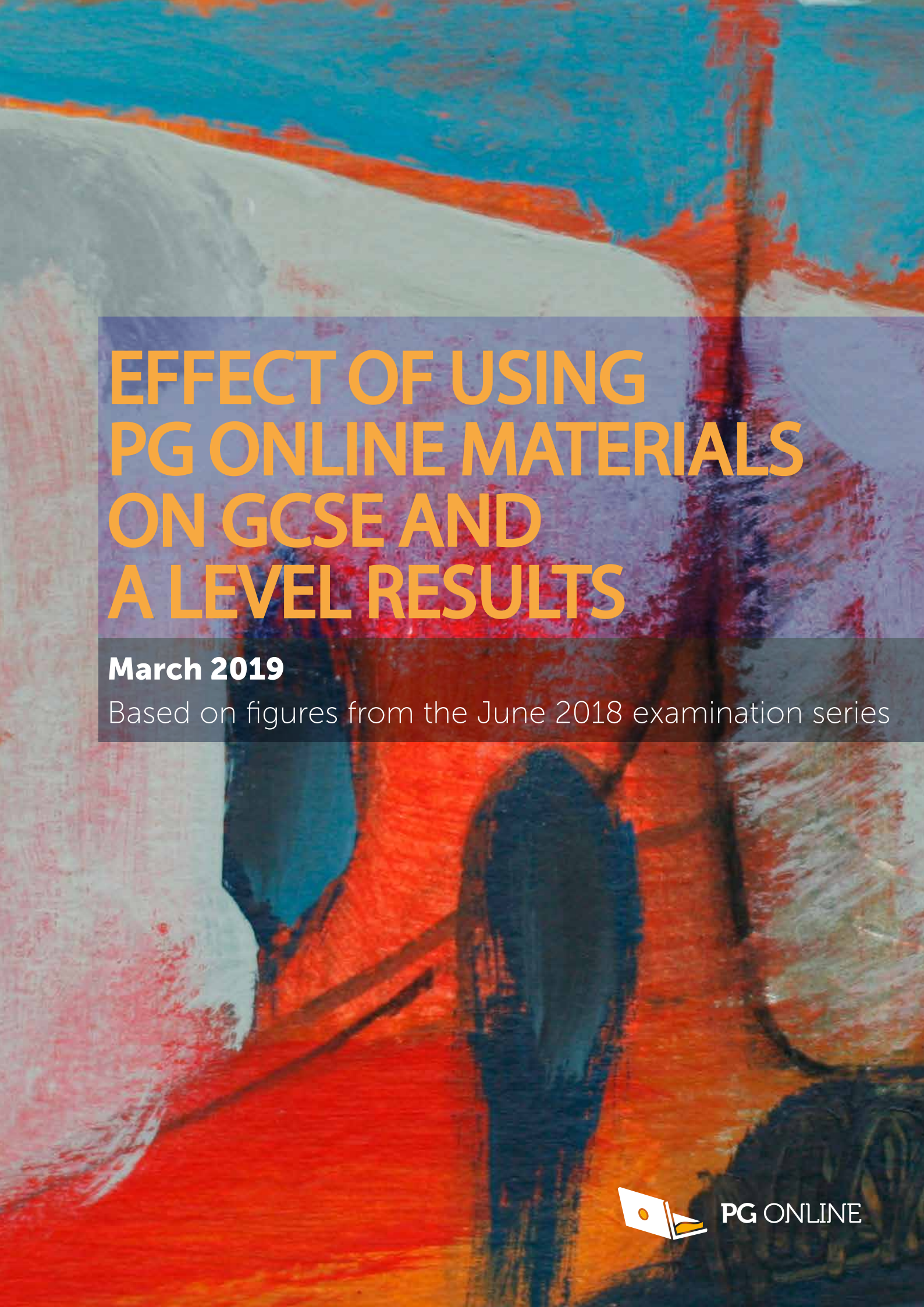

EFFECT OF USING PG ONLINE MATERIALS ON GCSE AND A LEVEL RESULTS

March 2019

Based on figures from the June 2018 examination series

PG ONLINE

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Front cover image
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Foreword

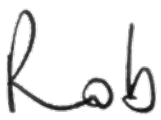
Over the past five years, we have strived to provide a new benchmark of lesson quality and engagement for students whilst saving teachers valuable time.

With the first major examination series completed for the 9-1 GCSE qualification for Computer Science in 2018, we have finally been able to commission an independent audit of the effectiveness of these materials.

In March 2018, Select Statistics of Exeter were able to confirm that of those schools that had purchased our KS3 Computing resources more than two years prior to the Summer 2017 GCSE examination series, a small but significant increase in GCSE results was found. This was the equivalent of 0.01 of a grade per KS3 purchased; so each additional teaching unit purchased at KS3 to support the GCSE qualification was associated with increased GCSE scores up to a maximum of 0.2 or 20% of a grade increase two or more years later. Whilst small, the long-term strategy and impact of getting the foundations right for students at KS3 indicate some positive results for these schools.

This year, we are delighted to find that the use of our GCSE and A Level teaching materials is associated with a quantifiable, positive significant improvement in results in schools where they are used and we look forward to continuing to support teachers and students in Computer Science and all our other subjects across the STEM area in 2019.

Thank you to those schools who have supported us over the past five years. I am thrilled that we can now offer some real evidence to support your decision in choosing us.



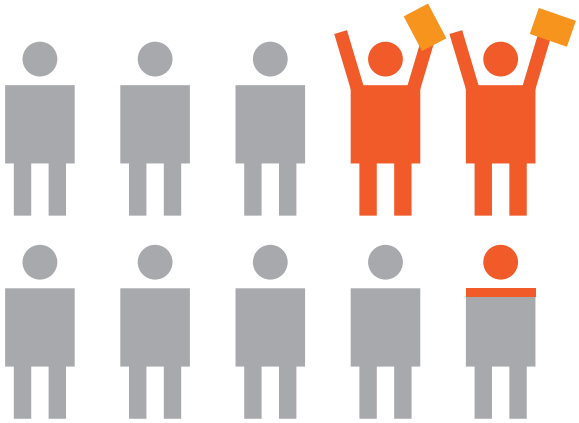
Rob Heathcote
Director, PG Online

Introduction

Select was pleased to be asked by PG Online, a publishing company providing resources for teachers of Design Technology, Computer Science, Business and Mathematics to analyse the latest Key Stage 4 and Key Stage 5 results published by the Department for Education (DfE).

They asked us to examine whether schools that purchased their Computer Science teaching resources were associated with higher GCSE and A Level points compared to schools that did not use their resources.

12% of students **improved** their **GCSE grade** in schools using PG Online GCSE Teaching Units



23% of students **improved** their **A Level grade** in schools using PG Online A Level Teaching Units

Data

Datasets

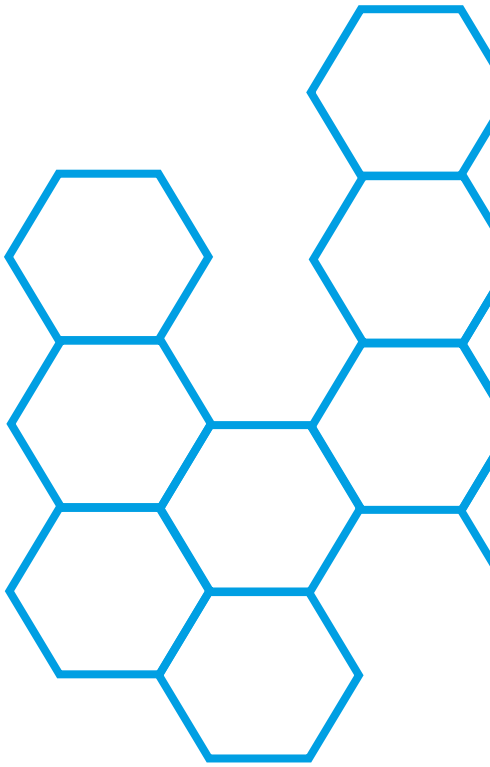
PG Online provided us with a tab-separated file which contained the names, addresses and school IDs of schools and organisations in the UK that had ordered A Level, GCSE and/or Key Stage 3 resources between November 2013 and January 2019.
School-level Key Stage 4 (KS4), including GCSE, and School-level Key Stage 5 (KS5), including A Level, performance results for schools in England for 2017/18, published by the DfE, were also provided. Our analysis considered GCSE and A Level grades in Computer Science/ Computing in particular.

Data processing

The summer of 2018 was the first time that the new Computer Science 9-1 specifications were examined at GCSE. PG Online's dataset contained purchase information for resources designed for this new curriculum and also for the legacy Computer Science GCSE curriculum. While the materials for the legacy GCSE were similar to the new GCSE, and purchasers of resources for the legacy GCSEs would still benefit from them, there is also a significant amount of new content in the updated curriculum. PG Online's dataset also included purchase information for resources for the International GCSE (IGCSE), though IGCSE results were not included in the KS4 results file. The legacy and IGCSE resources were not considered in our analysis.

In addition to the new curriculum at GCSE, in 2017/18 the grading system also changed, with GCSE grades ranging from Grade 9 to Grade 1 replacing the previous system of grades A* to U.

PG Online's customer dataset was provided. After removing organisations with blank school IDs (most of which were FE colleges or non-schools, e.g. universities) and Scottish, Welsh and Irish schools, plus removing 74 schools with duplicate school IDs, the dataset contained data for 4,713 English schools with unique URNs (unique reference numbers).



Variable definitions

The 4,713 schools in PG Online's database were then matched to the KS4 and KS5 results respectively, using schools' URNs. Available school background information contained in the KS4 file and the Annual School Census (ASC) were also matched, again using URNs. Available background variables were:

- school type (academies & free schools, independent, and local authority (LA) maintained, with the addition of sixth form colleges, FE colleges and university technical colleges for the A level model)
- region,
- number of pupils on roll,
- the percentage of pupils eligible for free school meals (FSM),
- the percentage of pupils with a statement of special educational needs (SEN) or an education, health and care (EHC) plan, and
- the percentage of pupils with SEN support but without a statement or EHC plan.

Of the total English schools in PG Online's database that had bought at least one GCSE unit, 38 schools didn't match to the DfE data, potentially due to URN changes; and 184 schools that purchased GCSE units didn't have Computer Science GCSE results available for the summer of 2018. A remainder of PG Online schools were not included in the model due to missing data on one or more of the model variables (including GCSE results that were suppressed due to small numbers). The final dataset used for analysis included 1,011 schools, with a total of 29,321 students, that were PG Online customers and 1,155 schools, with a total of 30,278 students, that were not PG Online customers.

There were 606 English schools in PG Online's database that had bought at least one A level unit, excluding any free materials, which matched to the file of A level results. The remaining PG Online schools excluded from this figure will be a combination of schools that didn't match to the DfE data and schools that purchased A Level units but didn't have Computer Science A level results available for the summer of 2018. The DfE suppresses results based on fewer than 5 pupils, so these schools on PG Online's database were not included in the modelling due to missing (suppressed) data. Suppressed data also meant that a similar proportion of non-PG Online schools were also not included in the modelling. A further set of PG Online schools were omitted from the modelling due to other missing data. The final dataset used for analysis included 122 schools, with a total of 1,300 students, that were PG Online customers and 101 schools, with a total of 1,168 students, that were not PG Online customers.

"The final dataset used for analysis included 1,011 schools, with a total of 29,321 students, that were PG Online customers and 1,155 schools, with a total of 30,278 students, that were not PG Online customers."

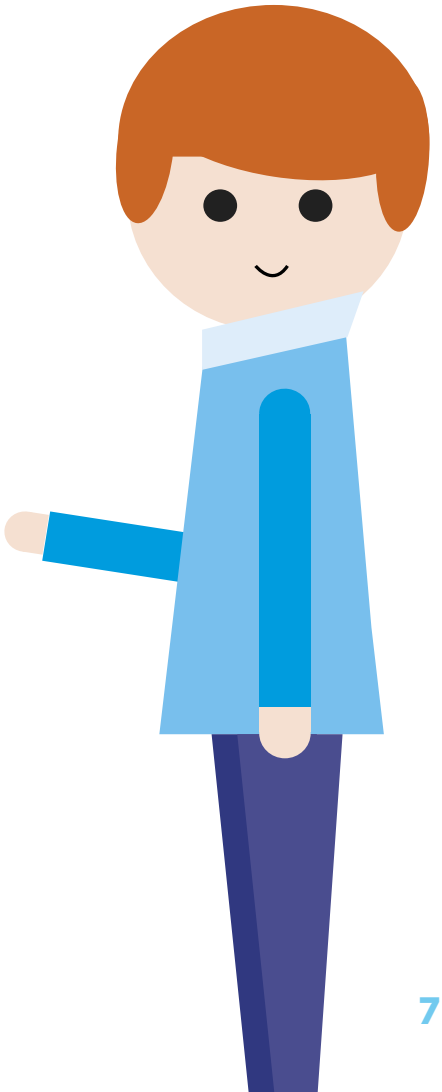
The outcome variable used in the GCSE analysis was each school's average GCSE point score in Computer Studies. It was calculated for each school by allocating 1-9 points for students at each of the grades 1 to 9, respectively, and dividing by the number of students obtaining a result. So, for example, if a school has 10 pupils with GCSE Computer Studies results and one achieved a Grade 9, one achieved a Grade 8, 3 achieved Grade 6s, 4 achieved Grade 4s and one a Grade U, their average GCSE point score was:

$$\frac{(9\times1)+(8\times1)+(6\times3)+(4\times4)+(1\times0)}{10} = 5.1$$

The outcome variable used in the A level analysis, again, was each school's average A level point score in Computer Studies. It was calculated in the same fashion as above but by allocating 8 points for an A* grade, 7 points for a grade A, 6 points for a grade B, etc., and dividing by the number of students entered. (Note: This is slightly different from the average GCSE point score where the denominator was number of students with a result).

In each of the KS4 and KS5 analyses, schools' average GCSE point score or A level point score, respectively, for 2016/17 was included as a comparison of prior attainment in Computer Science. These were calculated in an equivalent way.

For each school in PG Online's dataset, we calculated the number of A Level units and the number of new curriculum GCSE units each had purchased (units for the legacy GCSEs and IGCSEs were discounted). We decided to discount units for A levels and GCSEs that were purchased more recently than 1st April 2018, as units purchased more recently than this date were unlikely to have benefitted the students in each exam cohort.



Methods

Linear regression models were used to analyse both the schools' GCSE results and A level results.

An explanatory variable that indicated whether or not a school had purchased one or more GCSE or A level units was included in the respective model, along with the available school background information and each school's prior attainment.

All independent schools had missing FSM data. Rather than omitting independent schools from the GCSE and A level modelling, FSM was coded as zero for independent schools. The consequence of this is that the estimated effect for independent schools not only captures differences associated with this school type, but also accounts for any differences in the socio-economic demographics of independent schools that cannot be accounted for via the FSM variable.

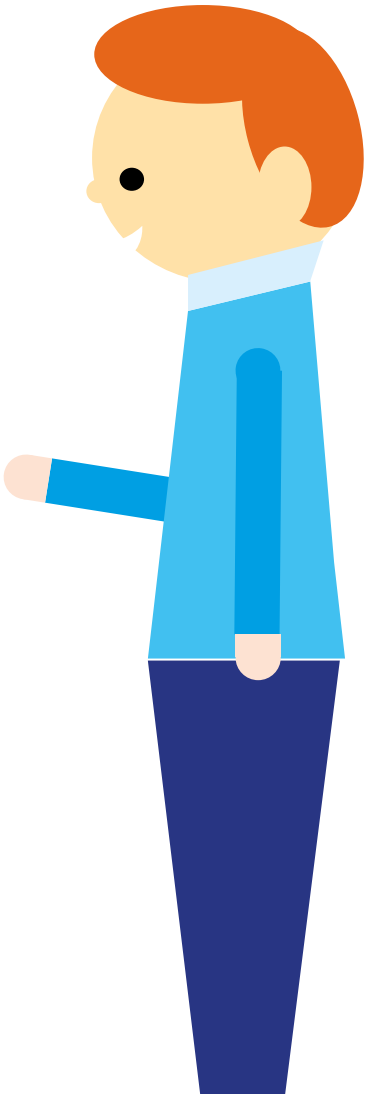
Independent schools have many bursary students and so an FSM figure of zero is an underestimate of the socio-demographics in independent schools. The estimated effect associated with independent schools cannot therefore be directly interpreted as a realistic representation of the achievement of independent school students. The effect of grade improvement in independent schools may also be less pronounced given the historically high performance and narrower room for improvement in examination results.

In the A level model, all sixth form colleges and FE colleges also had missing FSM, SEN and school size data. These were similarly coded as zero, and again the respective school type variable also accounts for any differences in their demographics not accounted for by these variables.

For each categorical variable, one category was chosen as a reference level, to which the other categories were compared. For school type, the reference category was LA maintained schools. The reference category for region was London.

A stepwise model selection was used to select which of the available variables were to be included in the final models. Stepwise regression is a method for exploring statistical models within a nested structure. **Akaike's Information Criterion (AIC)**[1], a measure of model fit that has a penalty for the number of parameters in the model, is commonly used to discriminate between the models. Starting with the model containing all independent variables, the AIC of each sub-model containing all parameters except one is computed. The algorithm then selects the model with the lowest AIC. At the next step all models obtained by deleting a single independent variable or by adding one back in that had previously been deleted are evaluated and, again, the model with the lowest AIC value is selected. The algorithm continues until adding or deleting a dependent variable from the model produces no improvement in the AIC. Stepwise regression is routinely used for variable selection problems where the best combination of independent variables is required.

In both the GCSE and the A level models, as an alternative to a dichotomous variable indicating whether or not a school had purchased materials, a count of the number of units purchased was also considered, both as a continuous variable and as a categorical variable (grouped into 0 units, 1 units, 2-7 units and 8+ units).



[1] https://select-statistics.co.uk/resources/glossary-page/#akaikes-information-criterion-aic

Model results

In the case of both the GCSE and the A level model, the model of best fit based on the AIC was the model that included the indicator of whether a school had purchased any units; using the number of units purchased, either as a numeric variable or a categorical variable produced higher AIC values.

GCSE Model

In the Tables section of this report, Table 1 shows the results for the final GSCE model, giving the model coefficients, their standard errors, 95% confidence intervals, the associated t-statistic and p-value.

The coefficients for independent or academies and free schools show how those schools compare to LA maintained schools. The coefficients for the different regions show how schools in those regions compare to schools in London. For continuous variables (percentage of pupils eligible for FSM, percentage of pupils with SEN, and number of pupils) the coefficient indicates the estimated change in average point score for each 1 unit change in the background variable.

The model coefficients are interpreted as being the estimated difference associated with each variable or attribute in turn, while all other variables and attributes remain the same, comparing like-for-like. So the coefficient for academies and free schools compares their results to the results for LA maintained schools that are the same size, with the same level of FSM, for example.

The GCSE model indicates that:

- Compared to other similar schools, schools purchasing one or more of PG Online's GCSE units tend to have a higher average GCSE point score of 0.1225 points on average, with a 95% confidence interval of (0.046, 0.199).
- Schools with higher average GCSE point scores in 2016/17 tend to have higher average GCSE point scores in 2017/18; for each additional grade in 2016/17 the average grade in 2017/18 was estimated to be 0.5295 points higher.
- The average scores for independent schools tend to be -0.2872 points lower than for LA maintained schools, given their prior attainment and background characteristics. The average scores for academies and free schools were not found to be statistically significantly different from LA maintained schools.

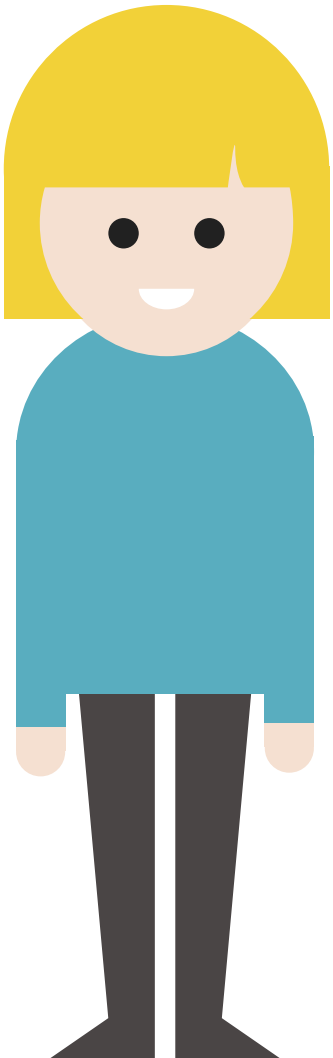
- Compared to other similar schools, schools with higher levels of FSM tend to have lower average GCSE scores (for each additional percentage point in FSM rates schools' GCSE points score are estimated to be 0.0606 points lower; though as FSM rates increase, this difference reduces, as the squared FSM term has a small positive coefficient). Note that since FSM was coded as zero for independent schools, the coefficient for independent schools encapsulates not only differences that exist in independent schools (for example teaching styles or length of school day) but also socio-economic differences.
- Schools with both higher percentages of pupils with SEN or an EHC plan and schools with higher percentages of pupils with SEN support tend to have lower average point scores than other schools. For each additional percentage point in SEN and EHC rates schools' GCSE points score are estimated to be 0.0369 points lower, and for each additional percentage point in schools' rates of SEN support their GCSE points score are estimated to be 0.0082 points lower.
- There were regional variations in average GCSE points score; the average scores for schools in all regions were lower than for schools in London. These differences ranged from schools in the East Midlands, whose average GCSE points score was 0.523 points lower than schools in London, to schools in the North East, whose GCSE points score was 0.2751 points lower on average than schools in London.
- Larger schools tend to have higher average point scores than smaller schools (for each additional pupil average GCSE points score is estimated to increase by 0.0002).

A Level Model

Table 2, in the Tables section, shows the results for the A level model, giving the model coefficients, their standard errors, 95% confidence intervals, the associated t-statistic and p-value.

The A level model indicates that:

- Compared to other similar schools, schools purchasing one or more of PG Online's A level units tend to have a higher average A level point score by an estimated 0.2295 points, with a 95% confidence interval of (0.068, 0.391).
- Schools with higher average A level point scores in 2016/17 tend to have higher average A level point scores in 2017/18; for each additional grade in 2016/17 the average grade in 2017/18 tended to be 0.5293 points higher.
- Schools with higher percentages of pupils eligible for free school meals tend to have lower average A level point scores; for each additional percentage point in FSM rates schools' A level points scores are estimated to be 0.0181 points lower.



While the models do take account of differences between schools in terms of some background characteristics, there are, particularly in the A level model, both mismatching schools and missing data, which results in schools that are omitted from the analysis. If these schools have particular characteristics in common, characteristics common to schools with small cohorts for example, that are associated with the outcomes, then these characteristics may not be properly accounted for in the analysis. Additionally, there are many other differences between schools and students that could reasonably be associated with KS4 and KS5 outcomes that are not taken into account in the model. It is possible that there are other unmeasured factors or variables that could explain the differences in point scores seen in the model were we able to include this information.

Comments and Conclusions

The GCSE model indicated that, while taking account of a number of school background variables, schools purchasing one or more of PG Online's GCSE units tended to have higher average Computer Science GCSE point scores than other similar schools. This was statistically significant (at the 5% level) with a coefficient of 0.1225 of a GCSE grade. This can also be expressed approximately as 3 students out of every 25 would be expected to achieve one grade higher at GCSE.

Despite the high proportions of schools not included in the model due to government suppressed data, the A level model also indicated that, while taking account of a number of school background variables, schools purchasing one or more of PG Online's A level units tended to have higher average Computer Science A level point scores than schools with similar backgrounds. Statistically significant, the size of the difference was 0.2295 of a grade at A level. Again, this result can also be approximately expressed as just less than 6 students out of every 25 would be expected to achieve one grade higher at A level.

"3 students out of every 25 would be expected to achieve one grade higher at GCSE."

"6 students out of every 25 would be expected to achieve one grade higher at A level. "

Table 1: Regression results for average Computer Science GCSE point score 2017/18

Variable	Comparison	Coefficient	SE	95% CI	t-Statistic	p-value
Intercept		3.2594	0.183	(2.901, 3.617)	17.85	< 0.0001
Schools purchasing PG Online units	Schools not purchasing	0.1225	0.039	(0.046, 0.199)	3.16	0.0016
Average Computer Studies GCSE point						
score 2016/17		0.5295	0.019	(0.492, 0.567)	27.48	< 0.0001
Academies and Free schools	LA maintained schools	-0.0543	0.043	(-0.139, 0.03)	-1.26	0.2076
Independent schools	LA maintained schools	-0.2872	0.124	(-0.531, -0.044)	-2.31	0.0209
Percentage students eligible for FSM		-0.0606	0.005	(-0.071, -0.05)	-11.23	< 0.0001
Percentage FSM squared		0.0006	<0.001	(<0.001, 0.001)	7.98	< 0.0001
Percentage students with SEN statement						
or EHC plan		-0.0369	0.015	(-0.067, -0.007)	-2.44	0.0149
Percentage students with other SEN levels		-0.0082	0.004	(-0.016, -0.001)	-2.11	0.0353
Region - South East	London	-0.3754	0.076	(-0.524, -0.227)	-4.95	< 0.0001
Region - South West	London	-0.4097	0.083	(-0.571, -0.248)	-4.96	< 0.0001
Region - West Midlands	London	-0.392	0.08	(-0.548, -0.236)	-4.93	< 0.0001
Region - East Midlands	London	-0.523	0.088	(-0.695, -0.351)	-5.95	< 0.0001
Region - East	London	-0.439	0.081	(-0.597, -0.281)	-5.45	< 0.0001
Region - Yorkshire and The Humber	London	-0.4456	0.085	(-0.612, -0.279)	-5.24	< 0.0001
Region - North West	London	-0.4342	0.074	(-0.579, -0.289)	-5.87	< 0.0001
Region - North East	London	-0.2751	0.104	(-0.479, -0.071)	-2.64	0.0084
Number of pupils on roll		0.0002	<0.001	(<0.001, <0.001)	3.73	0.0002

Table 2: Regression results for average Computer Science A level point score 2017/18

Variable	Comparison	Coefficient	SE	95% CI	t-Statistic	p-value
Intercept		1.6931	0.196	(1.309, 2.077)	8.64	< 0.0001
Schools purchasing PG Online A level units	Schools not purchasing	0.2295	0.083	(0.068, 0.391)	2.78	0.006
Average Computer Science A level point						
score 2016/17		0.5293	0.051	(0.428, 0.63)	10.29	< 0.0001
Percentage students eligible for FSM		-0.0181	0.004	(-0.025, -0.011)	-4.87	< 0.0001

“

[In schools using PG Online materials, the] ... GCSE model indicated that 3 students out of every 25 would be expected to achieve one grade higher at GCSE.

At A level, just less than 6 students out of every 25 would be expected to achieve one grade higher at A level.”

Select Statistics, Exeter
March 2019

“

PG Online are one of the top 5 supporting organisations of Computing as indicated by surveyed teachers.”

The Royal Society,
After the reboot: Computing education in UK schools
November 2017

A winning formula with reassuring results

Our formula for lesson resources within Computer Science has been developed across the complete STEM curriculum with materials for Maths, Science and Technology adopting this ever-improving strategy for perfection and balance in teaching. We are confident that these results for Computer Science will, in time, be reflected in all of our subjects.

PG ONLINE

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