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The impact of GCSE maths reform on progression to A level

Research Report

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Executive Summary

Introduction

In February 2013, the Secretary of State for Education announced his intention to reform GCSEs “to ensure they are rigorous and robust, and give students access to high quality qualifications which match expectations in the highest performing jurisdictions”. For mathematics, in particular, the new GCSE would “focus on ensuring that every student masters the fundamental mathematics that is required for further education and future careers”, and, in particular, that it would “be more demanding” and “provide greater challenge for the most able students”.

The new GCSE in mathematics had, therefore, a revised content and aimed to better prepare students for progression to future education and employment. It was first assessed in summer 2017. Key changes to the qualification were a greater emphasis on problem-solving and more demanding content, together with a new grading scale.

This research explored how well the GCSE in mathematics prepares young people for further study in mathematics and subjects with significant mathematical content in the context of GCSE reform. In particular, it looked at students’ progression to level 3 mathematics and to different level 3 maths-related subjects, and at their performance in them pre- and post-reform.

The outcomes of this research will increase understanding of how recent reforms to the GCSE maths have affected students and will contribute evidence towards further understanding of progression from level 2 to level 3 mathematics.

Data and Methods

This work addressed the research question via quantitative analysis of national results data available in the National Pupil Database (NPD). Candidates who completed a GCSE maths in each of the years from 2014 to 2017 (June sessions only) were followed up for two years and the level 3 qualifications they achieved were included in the research.

Progression from GCSE maths to the following level 3 qualifications was then investigated: A level maths; Level 3 maths qualifications (AS level maths, A level maths, AS level further maths, A level further maths, core maths); and maths-related A level subjects (biology, chemistry, physics, economics, psychology).

Descriptive statistics on the number and proportion of GCSE maths students progressing to the qualifications listed above (overall and by GCSE grade), pre-reform (2014-2016) and post-reform (2017) were produced. Marginal grade distributions for all level 3 qualifications, overall and for each GCSE maths grade, pre-and post-reform were also produced.

To further explore the effect of GCSE reform on progression to and performance in level 3 maths or maths-related subjects, controlling for students’ backgrounds, multilevel logistic regression analyses were carried out.

Findings

Progression to A level maths

Contrary to fears of reduction in the uptake of A level maths following the reform this research showed that progression generally increased post-reform. However, when breaking it down by the grade achieved in GCSE maths, the increase in progression was higher amongst those who achieved at least grade A/7 than for students with at least grade C/4.

Performance in A level maths was, in general, lower post-reform. In particular, the probability of achieving at least grade A or at least grade C in A level maths was lower post-reform for students with any GCSE grade in maths, apart from the students at the very top of the GCSE grade distribution. However, it should be taken into account that students taking the reformed GCSE would have also taken the newly reformed A level in maths, and it is well known that student performance tends to dip slightly in the first years of a new qualification. Furthermore, research showed that the reformed A level specifications were significantly more demanding than legacy specifications, and there were concerns that while more able students may benefit from the more “aspirational” A level, lower performing students may be impacted negatively by the changes.

Progression to level 3 maths

Progression to any level 3 maths qualification decreased post-reform. This decrease was present across the full GCSE grade range. A likely explanation of this result is the decrease in the uptake of AS in maths in further maths in 2019, possible due to A level reform and the decoupling of AS and A levels.

Progression to individual level 3 maths qualifications such as core maths or A level further maths generally increased post-reform, independently of the grade achieved by the students in their GCSEs. The increase was slightly lower amongst students who achieved at least grade A/7 than amongst students who achieved at least grade C/4 in core maths, whilst the opposite pattern was found for A level maths.

Regarding performance in core maths and A level further maths, compared to the pre-reform years, students who achieved a GCSE maths post-reform were more likely to achieve top grades (grades A or B) in core maths. On the contrary, compared to the pre-reform years, students who achieved a GCSE maths post-reform were less likely to achieve both grade A or above and grade C or above in A level further maths.

Progression to maths-related A level subjects

This research investigated the impact of GCSE maths reform on five maths-related A levels (biology, chemistry, physics, economics, and psychology) and found that overall progression was higher post-reform in all subjects.

Compared to the pre-reform years, performance in maths-related subjects was generally worse post-reform. In particular, the A level science subjects (biology, chemistry, and physics) performance was very similar pre- and post-reform for students with the very top GCSE grades in maths, but it was lower post-reform for students with lower grades in GCSE maths. However, in economics and psychology, performance was very similar pre- and post-reform.

This research is set in the context of recent reforms to GCSEs and A levels and, as with any reforms, changes take time to bed in. Given that this research focussed on the first year after the reform (the new GCSE maths was first assessed in 2017), it is possible that the results do not reflect how the reformed GCSE maths will impact progression to and performance in level 3 maths and maths-related subjects over the coming years.

Introduction

In February 2013, the Secretary of State for Education announced his intention to reform GCSEs "to ensure they are rigorous and robust, and give students access to high quality qualifications which match expectations in the highest performing jurisdictions" (Gove, 2013). The reform focused on changes to English language, English literature, and mathematics in the first instance.

For mathematics, in particular, the new GCSE would "focus on ensuring that every student masters the fundamental mathematics that is required for further education and future careers", and, in particular, that it would "be more demanding" and "provide greater challenge for the most able students" (Gove, 2013).

The new GCSE in mathematics had, therefore, a revised content and aimed to better prepare students for progression to future education and employment. It was first assessed in summer 2017. Key changes to the qualification were a greater emphasis on problem-solving and more demanding content, together with a new grading scale from 9 to 1 (with 9 being the highest grade). More details about the subject content and the main assessment features of the new GCSE can be found in DfE (2013) or Ofqual (2017).

This research explores how well the GCSE in mathematics prepares young people for further study in mathematics and subjects with significant mathematical content in the context of GCSE reform. In particular, it looks at students' progression to level 3 mathematics and to different level 3 maths-related subjects, and at their performance in them pre- and post-reform. The outcomes of this research will increase understanding of how recent reforms to the qualification have affected students, teachers and schools, and contribute evidence towards further understanding of progression from level 2 to level 3 mathematics.

Background research

Prior to the GCSE reform, there were longstanding concerns about how well the GCSE in maths prepared students for progression to AS and A level study in mathematics.

Hernandez-Martinez *et al*. (2011) reported, drawing on interviews with students before and after the transition from school to college, that the GCSE in maths was inadequate preparation for many students with pass grades (especially grade C, but increasingly also grade B) for AS level study, with algebra being mentioned as the key problem. Similarly, Noyes and Adkins (2016) showed, using data from the National Pupil Database, that the numbers (and proportions) of GCSE maths grade C students completing any advanced mathematics were relatively small. In fact, around 99% of students achieving a grade C in 2010 did not complete any advanced mathematics over the following 3 years. For GCSE grade B students, the story was only marginally better.

Rushton and Wilson (2014) carried out a survey of teachers to identify the areas of mathematics that were problematic for students who had just completed the GCSE and wanted to study the subject further at A level. They showed that teachers believed that students were prepared adequately for AS and A level courses in most areas of mathematics, but they also identified other areas (*e.g.*, algebra) where GCSEs were considered not to prepare students well.

In a more recent study exploring the perceptions and experiences of the transition between GCSE and AS level mathematics of a small group of students, Rigby (2017) reported that the majority of students believed that the GCSE syllabus prepared them for the AS level syllabus but not to the extent they would have hoped. It was believed that a gap existed between the mathematics that are necessary to pass a GCSE and the mathematics that students need to be able to start AS or A level (*e.g*., Wiliam *et al*., 1999; Noyes & Sealey, 2011). As a result, most schools were requiring high grades for entry onto A level maths courses to make sure students were prepared for the transition: for example, students often had to have achieved a grade B at GCSE or even a grade A in order to be accepted for an AS or A level in maths (*e.g*., Noyes & Sealey, 2012). In Rigby's research (Rigby, 2017), one of the suggestions to improve the transition between GCSE and AS level was to change the GCSE syllabus to a more rigorous one, by including more AS level material (this has now been implemented within the reformed GCSEs). Although this should give students the necessary understanding of content and skills that are required at AS level, students of middle and low ability could struggle with the new qualification.

The tension between revising the GCSE qualification to be better preparation for the AS and A levels and ensuring that they were appropriate for students with lower grades who were not intending to continue to further study was problematic as, for example, including more rigorous content could have undesired effects on the transitions of some students.

Despite A level maths having a period of sustained growth in entries in the years prior to the GCSE reform (see, for example, Gill and Williamson (2016) and Gill (2018)), concerns about participation in post-16 maths have emerged in recent years. In particular, there have been concerns that the combination of the decoupling of AS and A levels, curriculum changes to the A level in maths, and changes to Key Stage 5 funding would lead to a reduction in the uptake of maths at level 3 (*e.g*., ALCAB, 2014; Lee *et al*., 2018; Redmond *et al*., 2020). Changes to the GCSE maths aimed to encourage students to better manage the transition to A level maths. However, the number of entries in A level maths fell by around 3.5% in 2019[1] (DfE, 2019; 2020a), with suggestions from school leaders that students might have been losing confidence in their abilities in the subject or being less inclined to take it as it was perceived as quite hard.

To date, there is not much published research on how the reform of GCSE maths has affected maths learning and, in particular, on how it affected progression to further education (*e.g*., entries to A levels) or performance in level 3 maths (*e.g*., AS and A level maths; AS and A level further maths) and maths-related subjects (*e.g*., Biology, Chemistry, Physics, Economics or Psychology).

One of the few studies that considered this issue in some detail was carried out by Ofqual (Howard & Khan, 2019). They conducted interviews with A level maths teachers with experience in teaching students who had studied the legacy GCSE in maths and students who had studied the reformed GCSE. The interviews explored their perceptions of how the legacy and reformed GCSEs prepared students for A level study. In general, teachers were positive about the extent to which the reformed GCSE prepared students for A level and the majority commented that the reformed GCSE prepared students at least as well, if not better, than the legacy GCSE. The participants also reported that the reformed GCSE had positive implications beyond studying A level maths and that it would support students studying other subjects with mathematical content.

[1] Students taking the A level maths in 2019 would have studied the reformed GCSE maths.

Humphries *et al*. (2017) also carried out a small qualitative study involving a sample of teachers (in 12 schools) who were engaged in delivering the new GCSE. Participating teachers expressed the view that "students sitting the reformed mathematics GCSE would be leaving Key Stage 4 with more mathematical knowledge than previous cohorts", and that this would apply across all attainment levels: "…there is additional content in both higher and foundation which would improve the standard, because obviously they've got to have more knowledge just at a very base level". This was an important point as it is well documented that participation in A level maths has been skewed toward those with high GCSE grades in the subject.

Grima and Golding (2019) and Pearson Education (2019), who carried out a programme of research looking at the introduction of the new GCSE maths, reported similar findings to those outlined above. However, although the general consensus was that the new GCSE prepared students well for A level, there were concerns about how the weaker students (those with a grade 5 or 6) would feel about their abilities in maths. This was also mentioned by the participants in a study by Lee *et al*. (2018) who reported on a large-scale survey of post-16 mathematics teachers carried out by MEI[2]. The participants in this study additionally suggested that they had seen a reduction in mathematical confidence for students at a grade A/7 level, observing that "with only 52% of the marks[3] required for a grade 7 it may be the case that students who would feel confident and capable of studying maths with a grade A in the past may no longer feel as confident and therefore as motivated to study the subject".

Aim of the research

The current research aims to add to the qualitative analysis of existing research described above by approaching the question on how the reform of GCSE maths has affected progression to further education (*e.g*., entries to A levels) or performance in level 3 maths and in maths-related subjects (*e.g*., achieving at least grade A at A level) via quantitative analysis of entries and performance data.

In particular, the main research question is:

> How does overall performance in GCSE maths relate to progression and subsequent attainment in level 3 qualifications with mathematical content, pre- and post- GCSE reform?

It should be noted that alongside GCSE reform, A levels have also been reformed. For example, students who sat the reformed maths GCSE in 2017 (first year of assessments after the GCSE reform) were the first full cohort[4] to sit the reformed maths and further maths A level in summer 2019.

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[2] MEI – Mathematics in Education and Industry (https://mei.org.uk/).

[3] This percentage (52% of the marks required for grade 7) was lower post-reform (in 2019) than in pre-reform years. However, it should be born in mind that grade boundaries in the first year(s) of reformed qualifications, as it is the case here, are usually lower than in pre-reform years and they gradually increase and stabilise over time to account for candidates' drop in performance (Cuff *et al*., 2019).

[4] A level maths was available after one year of study in summer 2018. The entries in summer 2018 were small and were mainly year 12 students also studying A level further maths.

Data and methods

Data

This work addressed the research question via quantitative analysis of national results data available in the National Pupil Database.

The National Pupil Database (NPD) is a longitudinal database for children in schools in England, linking pupil characteristics to school and college learning aims and attainment. It holds individual pupil level attainment data for pupils in all schools and colleges who take part in the tests/exams and pupil and school characteristics (*e.g.*, age, gender, ethnicity, special educational needs, eligibility for free school meals, etc.) sourced from the School Census for maintained schools only. The following extracts of the NPD data were used:

- Key Stage 4 Pupil & Exam data, linked to Spring Census for the academic years 2014 to 2017
- Key Stage 5 Pupil & Exam data, linked to Spring Census for the academic years 2016 to 2019

Candidates who completed a GCSE maths in each of the years in Table 1 below (June sessions only) were followed up for two years and data for level 3 qualifications in the four exam sessions before the end of Key Stage 5 were included. For example, students who achieved a GCSE maths in 2015 were followed up in 2016 and 2017 and their AS and A level results (in any November or June session in that period) identified.

Table 1: GCSE maths cohorts included in the research

GCSE exam year	A level completion	GCSE maths
2014	2016	Legacy (A*-G)
2015	2017	Legacy (A*-G)
2016	2018	Legacy (A*-G)
2017	2019	Reformed (9-1)

The analyses were restricted to students who were 16 years old at the end of the academic year. This age restriction was made to have a set of “typical” candidates at the end of Key Stage 4. The numbers of students who achieved a GCSE Maths in each year from 2014 to 2017, together with the grade distributions, are available in Appendix A.

As shown in Table 1, the grades available in the period of study were in two different grade scales: A*-G for the legacy GCSE qualifications, and 9-1 for the reformed GCSE. For some of the analysis in this study, the grades for pre- and post-reform GCSE maths were converted to a common numerical scale using the Department for Education’s conversion values for 2017 and 2018 performance table calculations (DfE, 2016) as shown in Table 2 below.

Table 2: GCSE grade scales (pre- and post- GCSE reform)

GCSE grade common scale	GCSE grade legacy	GCSE grade reformed
9		9
8.5	A*	
8		8
7	A	7
6		6
5.5	B	
5		5
4	C	4
3	D	3
2	E	2
1.5	F	
1	G	1
0	U	U

Progression from GCSE maths to the following level 3 qualifications was investigated:

- A level maths
- Level 3 maths (any): this included AS level maths, A level maths, AS level further maths, A level further maths, and core maths
- Core maths[5]
- A level further maths
- Maths-related A level subjects (any): biology, chemistry, physics, economics, and psychology
- A level biology
- A level chemistry
- A level physics
- A level economics
- A level psychology

[5] Core maths is a level 3 qualification aimed at students who have passed GCSE maths at grade 4 or above, but who have not chosen to study AS/A level maths. It helps students consolidate and extend their maths knowledge and provides them with transferable mathematical skills to support their other level 3 subjects (*e.g.*, psychology, geography, business-related courses, sports, and social sciences, …) and their transition to employment and further study. For more details see, for example, https://www.ocr.org.uk/qualifications/core-maths/.

Method

Descriptive statistics on the number and proportion of GCSE maths students progressing to the qualifications listed above, pre-reform (2014-2016) and post-reform (2017) were produced. Progression was investigated overall and by GCSE grade.

Marginal grade distributions for all qualifications above, overall and for each GCSE maths grade, pre-and post-reform were also produced.

To further explore the effect of GCSE reform on progression to and performance in level 3 maths or maths-related subjects, while controlling for students' backgrounds, multilevel logistic regression analyses were carried out. The outcomes (dependent variables) of the regressions were as follows:

- progression to A level maths;
- progression to level 3 maths (any, core maths, A level further maths);
- progression to maths-related subject (any, biology, chemistry, physics, economics, and psychology);
- achievement of specific grade thresholds (*e.g*., at least grade A; at least grade C) in A level maths, core maths, A level further maths, and all A levels in the maths-related subjects listed above.

The independent variables in the regression models included: year the GCSE maths was achieved (this is an indicator of pre-reform (2014 to 2016) or post-reform (2017)), GCSE grade (using the common GCSE grade scale described in Table 2), gender, overall prior attainment, level of deprivation and school type.

The level of attainment at Key Stage 4 (prior attainment) was measured by the *average GCSE and equivalents point score per entry* (for details on how this is calculated, see DfE (2017)). The average GCSE and equivalents point score per entry ranges from 0 to 9. This measure was used to divide students into three approximately equally sized groups: low attainment, medium attainment and high attainment. In each year, these terciles were based on the full Key Stage 4 cohort of students.

The level of income-related deprivation of the students was measured by the Income Deprivation Affecting Children Index (IDACI)[6]. This index is based on the student's home postcode and describes the percentage of children in a very small geographical area (Lower Layer Super Output Area or LSOA) living in low income families. It varies between 0 and 1 and indicates how income deprived the area in which a student lives is. It cannot, however, indicate how income deprived the student actually is. This measure was used to divide students into three approximately equally sized groups: low deprivation (more affluent), medium deprivation and high deprivation. As above, in each year, these terciles were based on the full Key Stage 4 cohort of students.

[6] For further information on IDACI calculation, including definitions of children, families, and income deprivation, see https://www.gov.uk/government/publications/english-indices-of-deprivation-2015-technical-report.

The NPD listed the centre at which candidates gained their Key Stage 4 qualifications, indicated by the centre's Unique Reference Number (URN). This number was used to match candidates to the Department for Education's register of educational establishments[7], providing information on the type of school (Gill, 2017). Based on their type, schools were classified into five groups: comprehensive schools, secondary modern schools, independent schools, selective schools, and other[8].

Note that some of the variables described above are collected as part of the annual school census, which is only compulsory for state-maintained schools (which do not include independent schools). This can lead to high levels of missing data among independent school students for some variables (*e.g.*, IDACI deprivation).

With logistic regression models such as the ones fitted in this research, estimates are hard to interpret directly because they are log odds of the outcome (*e.g.*, progressing to A level; achieving at least a grade A). But, in simple terms a positive parameter estimate (for a categorical variable) means that being in that category is associated with a higher probability compared to being in the reference category. Negative values mean a reduction in probability. A positive parameter estimate for a continuous variable means that the increase in that variable is associated with an increase in the probability of the outcome.

To aid interpretation, alongside the tables with the results from the regression analyses, figures are presented showing the probability of the outcome for different GCSE grades and broken down by the GCSE year.

Note: To ensure confidentiality of the data, statistical disclosure controls have been applied to the results (tables and graphs). In particular, counts below ten and percentages based on counts below ten have either been suppressed or merged with other counts.

[7] https://get-information-schools.service.gov.uk/.

[8] *Comprehensive* and *secondary modern* schools (which include free schools and academies) do not select their intake on the basis of academic achievement or the wealth of the parents of the students they accept. *Selective schools* are state-funded schools that admit students on the basis of some sort of selection criteria, usually academic. *Independent schools* are fee-charging private schools, independent from many of the regulations and conditions that apply to state-funded schools. *Other* schools included, for example, sixth form and further education colleges, special schools, pupil referral units, tutorial colleges, and training centres.

Results

Progression to A level maths

Overall progression

Table 3 and Figure 1 (see Table B1 in Appendix B for more details) below show the overall progression to A level maths of students who achieved a GCSE in maths pre- and post-reform. Progression to A level maths increased almost two percentage points post-reform. However, this increase could be a continuation of a trend already present pre-reform (Figure 1 shows that progression to A level maths had been increasing year on year in the last three years prior to the GCSE reform).

Table 3: Overall progression to A level maths, before and after the reform

	A level maths		
	Progression	N	%
Pre-reform (2014 – 2016)	No	1423803	90.5
	Yes	148915	9.5
Post-reform (2017)	No	470651	88.7
	Yes	59831	11.3

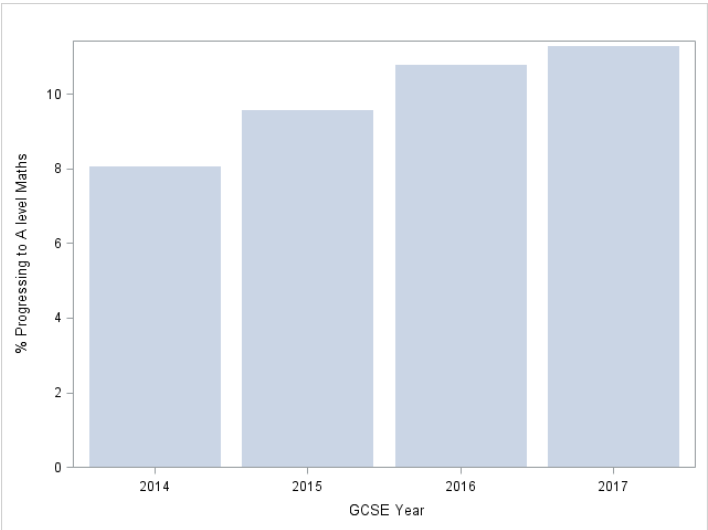


Figure 1: Overall progression to A level maths, by GCSE year (pre-reform: 2014 to 2016; post-reform: 2017)

Progression by GCSE grade

Table 4 shows the progression to A level maths broken down by achievement in GCSE maths, pre- and post-reform. Progression increased post-reform for all students, independently of the grade achieved at GCSE. However, the increase in progression rates was higher amongst those who achieved at least grade A/7 (+5.5 percentage points) than for students with at least grade C/4 (+2.4 percentage points). Figure 2 (see Table B2 in Appendix B for more details) shows progression by GCSE year.

Table 4: Progression to A level maths, by achievement of GCSE grade thresholds (A/7 or above; C/4 or above)

	GCSE grade	GCSE	A level maths	
		N	N	%
Pre-reform (2014 – 2016)	A / 7 or above	293800	135846	46.2
	C / 4 or above	1100647	148656	13.5
Post-reform (2017)	A / 7 or above	106759	55174	51.7
	C / 4 or above	376919	59822	15.9

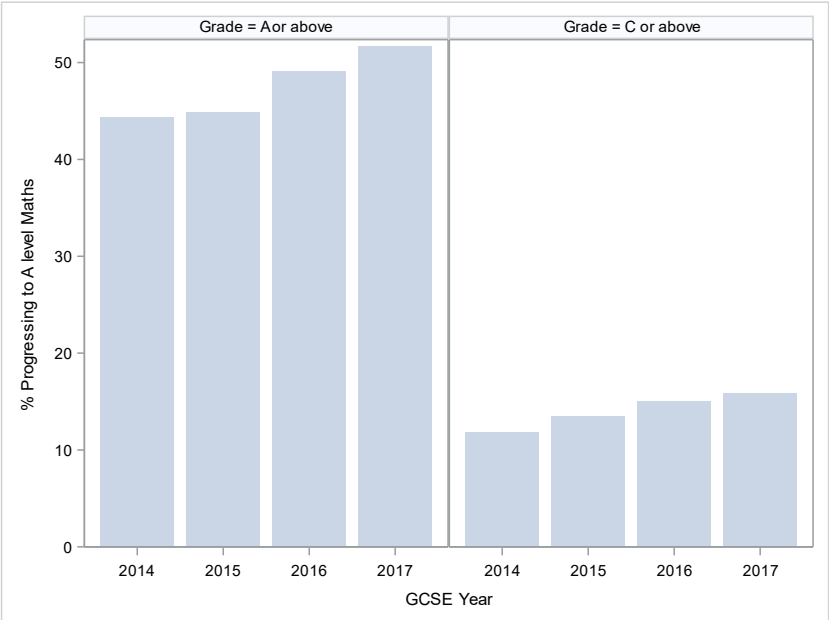


Figure 2: Overall progression to A level maths, by GCSE year (pre-reform: 2014 to 2016; post-reform: 2017) and achievement of GCSE grade thresholds: A/7 or above and C/4 or above

Table 5 shows progression by the individual GCSE grade. It is clear that there is hardly any progression to A level maths amongst candidates who achieved grade C/4 or below, both pre- and post-reform. Progression at grade A/7 post-reform (GCSE year 2017) was very similar to progression in a couple of pre-reform years (GCSE years 2014 and 2015), although slightly lower than in the last pre-reform year (2016).

Table 5: Progression to A level maths, by individual GCSE grade

GCSE year	GCSE grade	GCSE candidates	Progressing to A level	
			N	%
2014	A*	28043	20322	72.5
	A	55386	16725	30.2
	B	100264	3567	3.6
	C or below	322269	77	0.0
2015	A*	39853	27189	68.2
	A	66214	20445	30.9
	B	110379	4297	3.9
	C or below	328538	107	0.1
2016	A*	37179	27891	75.0
	A	67125	23274	34.7
	B	109433	4946	4.5
	C or below	308035	75	0.0
2017	9	19145	16720	87.3
	8	35877	22572	62.9
	7	51737	15882	30.7
	6	59036	4217	7.1
	5	99787	410	0.4
	4 or below	264900	30	0.0

Performance in A level maths

Figure 3 (Table B3 in Appendix B) shows the A level maths grade distribution for the cohorts of students progressing to A level maths who achieved a GCSE in 2014 to 2016 (pre-reform) and in 2017 (post-reform). Compared to the last year pre-reform (2016), students who achieved a GCSE maths post-reform (2017) were more likely to achieve an A* grade at A level, but they were less likely to achieve grades A or B. On the contrary, the percentages of students achieving grade D or E at A level were higher post-reform.

Table 6 offers a more detailed view of the A level maths grade distribution pre- and post-reform, breaking it down by GCSE grade. Only progression from GCSE grade C / 5 or above is shown, as the numbers of candidates progressing to A level maths with a GCSE grade below C (2014-2016) or 5 (2017) were very small. Looking at GCSE students who achieved, for example, grade A/7, Table 6 shows that there were lower proportions of candidates achieving grades A* to B post-reform than pre-reform.

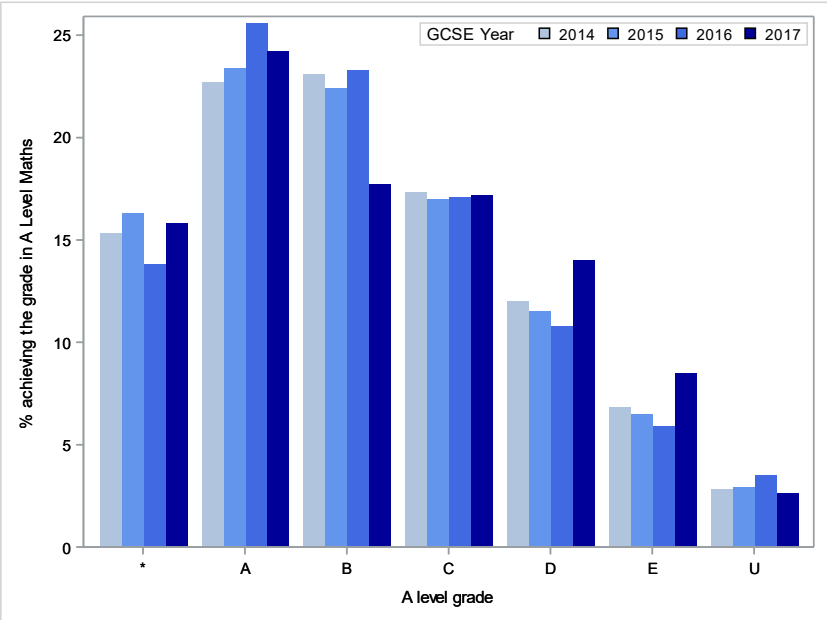


Figure 3: A level maths grade distribution, by GCSE year (students progressing from GCSE maths)

Table 6: A level maths grade distribution, by GCSE year and GCSE maths grade (C / 5 or above)[9]

GCSE year	GCSE grade	A level Maths grade						
		*	A	B	C	D	E	U
2014	A*	27.1	34.1	22.3	10.3	4.1	1.7	0.4
	A	4.0	13.0	26.1	24.7	18.6	10.0	3.6
	B	1.3	4.1	14.3	22.5	25.3	21.0	11.5
	C	24.3				18.6	21.4	35.7
2015	A*	28.0	34.1	21.2	10.2	4.3	1.7	0.4
	A	3.8	13.5	25.6	24.8	18.3	9.9	4.0
	B	1.2	3.8	14.1	23.7	24.7	20.0	12.5
	C	29.5				20.0	12.6	37.9
2016	A*	25.6	38.0	21.8	9.0	3.6	1.4	0.5
	A	2.6	15.3	27.0	25.6	16.5	8.8	4.2
	B	0.6	4.2	14.0	22.8	24.6	18.0	15.9
	C	33.3				18.2	48.5	
2017	9	45.7	36.3	11.1	4.7	1.7	0.5	
	8	7.2	30.0	25.7	20.5	11.6	4.4	0.6
	7	1.0	9.5	16.5	25.9	26.3	16.8	4.0
	6	3.4		7.7	16.4	28.8	28.5	15.2
	5	3.2		3.4	9.5	22.2	28.5	33.2

[9] Counts from which percentages were calculated are given in Table B4 in Appendix B. Note that some cells have been combined to comply with the statistical disclosure controls.

Regression analysis

As described on Page 13, to further explore the effect of GCSE reform on progression to and performance in A level maths, controlling for students' backgrounds (*e.g.*, gender; overall prior attainment; level of deprivation; school type), multilevel logistic regression analyses were carried out.

The outcomes (dependent variables) of the regression models were as follows:

- progression to A level maths
- achievement of specific grade thresholds in A level maths (at least grade A; at least grade C).

Table 7 shows the results of the regression model looking at progression to A level maths and Figure 4 (using data from Table 7) shows the probability of progressing to A level maths for a female student, of medium prior attainment, of medium level of deprivation, and in a comprehensive school.

Table 7: Progression to A level maths, regression analysis results (N = 1761038)

Variable		Estimate	Standard Error	Pr > |t|
Intercept		-16.361	0.073	<.0001
Gender	Male	0.951	0.008	<.0001
	[Female]	.	.	.
Deprivation	Medium	0.005	0.009	0.5890
	High	0.087	0.012	<.0001
	[Low]	.	.	.
Prior attainment	Medium	2.827	0.050	<.0001
	High	3.432	0.048	<.0001
	[Low]	.	.	.
School Type	Independent	-1.028	0.594	0.0836
	Other	-0.259	0.143	0.0706
	Secondary Modern	-0.057	0.059	0.3357
	Selective	-0.160	0.045	0.0004
	[Comprehensive]	.	.	.
GCSE Maths Grade		1.641	0.007	<.0001
GCSE Exam Year	2014	1.041	0.075	<.0001
	2015	1.237	0.071	<.0001
	2016	1.557	0.069	<.0001
	2017	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	-0.151	0.011	<.0001
	2015	-0.166	0.010	<.0001
	2016	-0.190	0.010	<.0001
	2017	.	.	.

Table 7 shows that the year the GCSE was taken was a statistically significant predictor of progression to A level maths, and its effect varied (significantly) by grade. For example:

- A candidate with grade 4 in GCSE maths, had a very similar (and very low) probability of progression pre- and post-reform: a probability of 0.01 to progress to A

level maths pre-reform (taking 2015 as an example, but very similar for the other pre-reform years) and a probability of 0.01 after the reform.

- A candidate with grade 7 in GCSE maths, had similar probability of progression pre- and post-reform: a probability of 0.12 to progress to A level maths pre-reform (as above, in 2015) and a probability of 0.11 after the reform.
- However, the very top candidates had different probability of progression pre- and post- reform: a candidate with grade A* pre-reform (2015, A*=8.5) had a probability of progression of 0.56, whilst candidates with grade 9 post-reform had a probability of 0.78.

  It is important to note that, although we are reporting progression rates for the top candidates before and after the reform (grade A* candidates *vs*. grade 9 candidates), grades A* and 9 are not comparable and, on average, the top candidates were "better" post-reform (see Table 2).

Figure 4 corroborates the above, showing that towards the top of the GCSE distribution, the progression to A level becomes very slightly higher for students who achieved the GCSE in 2017 (post-reform).

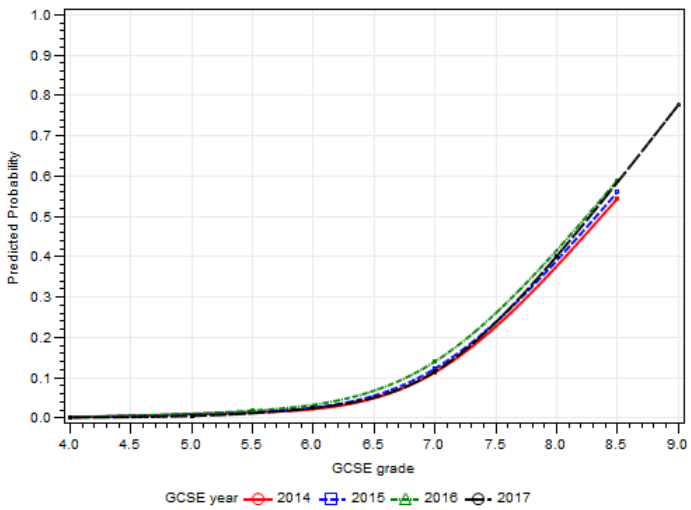


Figure 4: Probability of progression to A level maths, by GCSE year and GCSE maths grade (Gender=Female; Prior attainment=Medium; Deprivation=Medium; School type=Comprehensive)

Table 8 shows the results of the regression analyses looking at the performance in A level maths (*i.e*., achieving at least grade A; achieving at least grade C) pre- and post-reform.

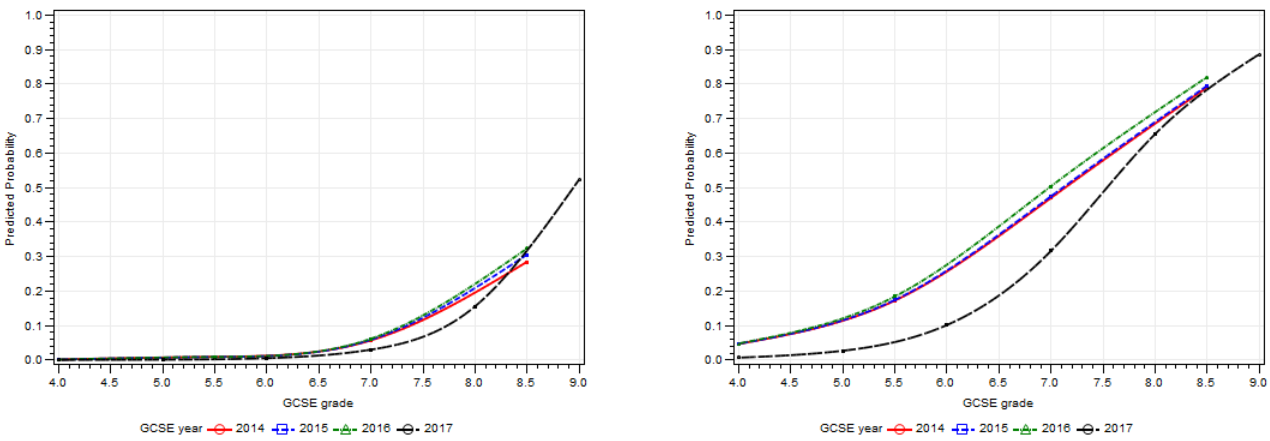
Table 8: Achievement of grade thresholds in A level maths, regression analysis results (N = 176398)

Variable		At least Grade A			At least Grade C		
		Estimate	Standard Error	Pr > |t|	Estimate	Standard Error	Pr > |t|
Intercept		-14.367	0.183	<.0001	-10.014	0.165	<.0001
Gender	Male	0.405	0.013	<.0001	0.227	0.015	<.0001
	[Female]	.	.	.	0.000	.	.
Deprivation	Medium	-0.134	0.014	<.0001	-0.156	0.016	<.0001
	High	-0.239	0.018	<.0001	-0.181	0.020	<.0001
	[Low]	.	.	.	0.000	.	.
Prior attainment	Medium	-1.472	0.127	<.0001	-0.479	0.118	<.0001
	High	-0.555	0.122	<.0001	0.352	0.116	0.0025
	[Low]	.	.	.	0.000	.	.
School Type	Independent	0.869	1.194	0.4668	1.660	1.203	0.1677
	Other	0.224	0.213	0.2936	0.544	0.225	0.0155
	Secondary Modern	-0.431	0.066	<.0001	-0.376	0.065	<.0001
	Selective	0.252	0.038	<.0001	0.252	0.044	<.0001
	[Comprehensive]	.	.	.	0.000	.	.
GCSE Maths Grade		1.785	0.017	<.0001	1.411	0.016	<.0001
GCSE Exam Year	2014	4.364	0.197	<.0001	3.770	0.167	<.0001
	2015	4.079	0.184	<.0001	3.757	0.156	<.0001
	2016	3.992	0.176	<.0001	3.651	0.152	<.0001
	2017	.	.	.	0.000	.	.
GCSE Maths Grade * GCSE Exam Year	2014	-0.528	0.024	<.0001	-0.446	0.023	<.0001
	2015	-0.482	0.023	<.0001	-0.441	0.021	<.0001
	2016	-0.462	0.022	<.0001	-0.409	0.021	<.0001
	2017	.	.	.	.	.	.

As for progression to A level maths, the year the GCSE was taken was a statistically significant predictor of performance in A level maths, and its effect varied (significantly) by grade. In particular, both Table 8 and Figure 5 below show that the probability of achieving at least grade A or at least grade C at A level was lower post-reform (2017) than pre-reform (2014-2016), apart from for the students who achieved the top GCSE grades. In particular:

- A candidate with grade 7 in GCSE maths, had a higher probability of achieving at least a grade A at A level pre-reform than post-reform: a probability of 0.06 pre-reform (taking 2015 as an example, but very similar for the other pre-reform years) and a probability of 0.03 after the reform. However, top candidates had a lower probability of achieving at least a grade A at A level pre-reform: a candidate with grade A* pre-reform (2015, A*=8.5) had a probability of 0.31, whilst candidates with grade 9 post-reform had a probability of 0.52.
- Similarly, a candidate with grade 7 in GCSE maths, had a higher probability of achieving at least a grade C at A level pre-reform than post-reform: a probability of 0.47 pre-reform (taking 2015 as an example, but very similar for the other pre-reform years) and a probability of 0.32 after the reform. However, top candidates had a lower probability of achieving at least a grade A at A level pre-reform: a candidate with grade A* pre-reform (2015, A*=8.5) had a probability of 0.79, whilst candidates with grade 9 post-reform had a probability of 0.89.

As mentioned above, although we are reporting progression rates for the top candidates before and after the reform (grade A* candidates *vs*. grade 9 candidates), grades A* and 9 are not comparable and, on average, the top candidates were "better" post-reform (see Table 2).



(a) Grade A or above

(b) Grade C or above

Figure 5: Probability of achieving a grade or above in A level maths, by GCSE year and GCSE maths grade (Gender=Female; Prior attainment=Medium; Deprivation=Medium; School type=Comprehensive)

Progression to level 3 maths qualifications

In this section, progression from GCSE maths to any level 3 maths qualification was investigated. The category “any level 3 maths” includes the following qualifications:

- A level maths
- AS level maths
- A level further maths
- AS level further maths
- Core maths

Alongside results for “any level 3 maths” qualifications, progression to and performance in A level further maths and core maths are reported separately.

Overall progression

Table 9 and Figure 6 (see Table C1 in Appendix C for more details) below show the overall progression to any level 3 maths qualifications of students who achieved a GCSE in maths pre- and post-reform.

Progression to any level 3 maths qualifications was slightly lower post-reform (just two percentage points lower). This could be due, in part, to the decrease in uptake of the AS in maths and further maths in 2019, the first year of the AS/A level maths reform (Ofqual, 2019).

Table 9: Overall progression to level 3 maths qualifications, before and after the reform

	Progression	Any level 3 maths		Core maths		A level further maths	
		N	%	N	%	N	%
Pre-reform (2014 – 2016)	No	1332976	84.8	1564233	99.5	1549757	98.5
	Yes	239742	15.2	8485	0.5	22961	1.5
Post-reform (2017)	No	459752	86.7	525400	99.0	521135	98.2
	Yes	70730	13.3	5082	1.0	9347	1.8

Table 9 also shows progression to core maths and A level further maths, specifically. In both cases, there is higher progression post-reform (although progression is low both pre- and post-reform). This is confirmed by the trends shown in Figure 7(a) for core maths and Figure 7(b) for the A level in further maths. Data for these graphs is given in Table C2 in Appendix C.

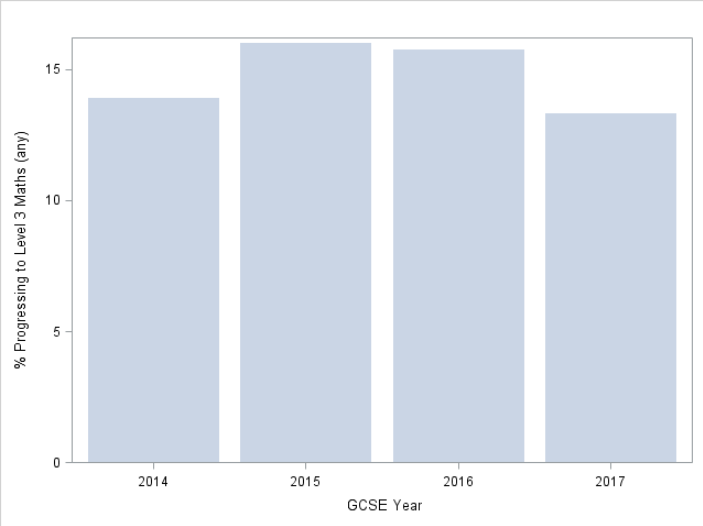
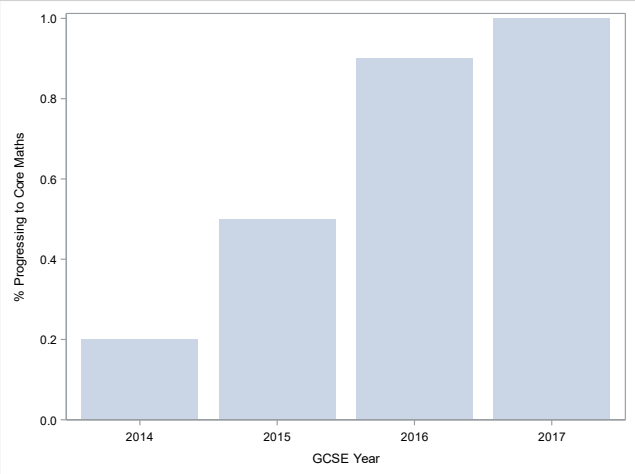
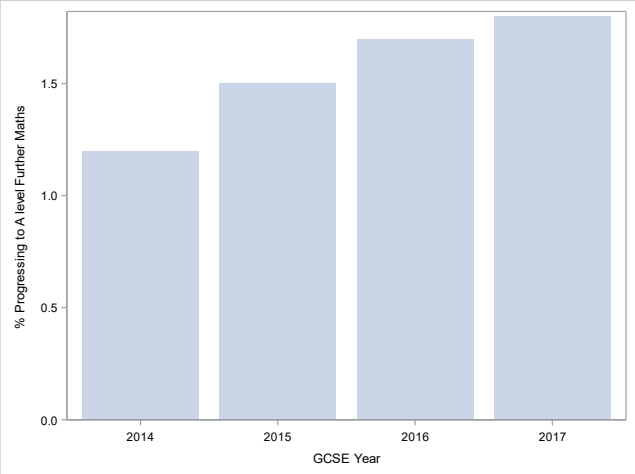


Figure 6: Overall progression to any level 3 maths qualification, by GCSE year (pre-reform: 2014 to 2016; post-reform: 2017)



(a) Core maths



(b) A level further maths

Figure 7: Overall progression to level 3 maths qualifications, by GCSE year (pre-reform: 2014 to 2016; post-reform: 2017)

Progression by GCSE grade

Any level 3 maths qualification

Table 10 and Figure 8 (see Table C3 in Appendix C for more details) show the progression to any level 3 maths qualification broken down by achievement in the GCSE, pre- and post-reform. Progression decreased post-reform, independently of the grade achieved by the students in their GCSEs.

Table 11 shows progression by the individual GCSE grade. There was very low progression to level 3 maths qualifications amongst candidates who achieved grade C/4 or below, both pre- and post-reform. Table 11 also shows that progression decreased at all GCSE grades.

Table 10: Progression to any level 3 maths qualifications, by achievement of GCSE grade thresholds (A/7 or above; C/4 or above)

	GCSE grade	GCSE	Level 3 maths (any)	
		N	N	%
Pre-reform (2014 – 2016)	A / 7 or above	293800	189944	64.7
	C / 4 or above	1100647	234831	21.3
Post-reform (2017)	A / 7 or above	106759	60464	56.6
	C / 4 or above	376919	70688	18.8

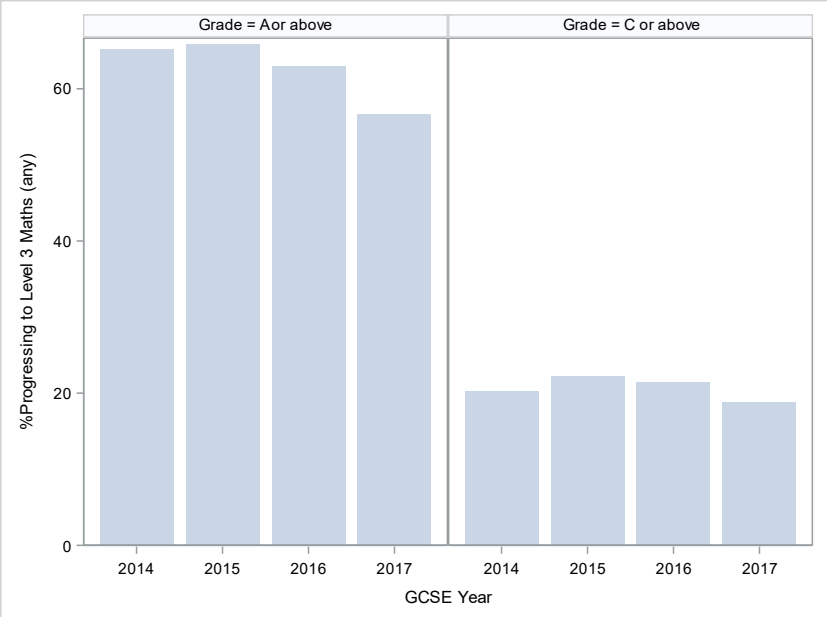


Figure 8: Overall progression to any level 3 maths qualifications, by GCSE year (pre-reform: 2014 to 2016; post-reform: 2017) and achievement of GCSE grade thresholds: A/7 or above and C/4 or above

Table 11: Progression to any level 3 maths qualification, by individual GCSE grade

GCSE year	GCSE grade	GCSE candidates	Progressing to level 3 maths (any)	
			N	%
2014	A*	28043	23827	85.0
	A	55386	30565	55.2
	B	100264	14762	14.7
	C or below	159102	1204	0.8
2015	A*	39853	33863	85.0
	A	66214	35977	54.3
	B	110379	15548	14.1
	C or below	168129	1742	1.0
2016	A*	37179	30952	83.3
	A	67125	34760	51.8
	B	109433	14577	13.3
	C or below	159540	1746	1.1
2017	9	19145	17041	89.0
	8	35877	24146	67.3
	7	51737	19277	37.3
	6	59036	7091	12.0
	5	99787	2437	2.4
	4 or below	111337	696	0.6

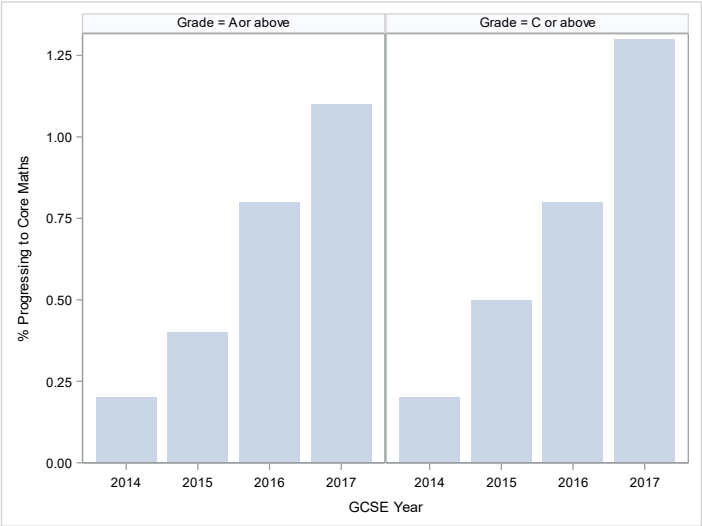
Core maths and A level further maths

Table 12 and Figure 9 (see Table C4 in Appendix C for more details) show the progression to core maths and A level further maths broken down by achievement in the GCSE, pre- and post-reform. Progression to both core maths and A level further maths increased post-reform, independently of the grade achieved by the students in their GCSEs. In core maths, the increase was slightly lower amongst students who achieved at least grade A/7 than amongst students who achieved at least grade C/4 (+0.6 *vs*. +0.8 percentage points), whilst the opposite pattern was found for A level maths (+0.9 *vs*. +0.4 percentage points).

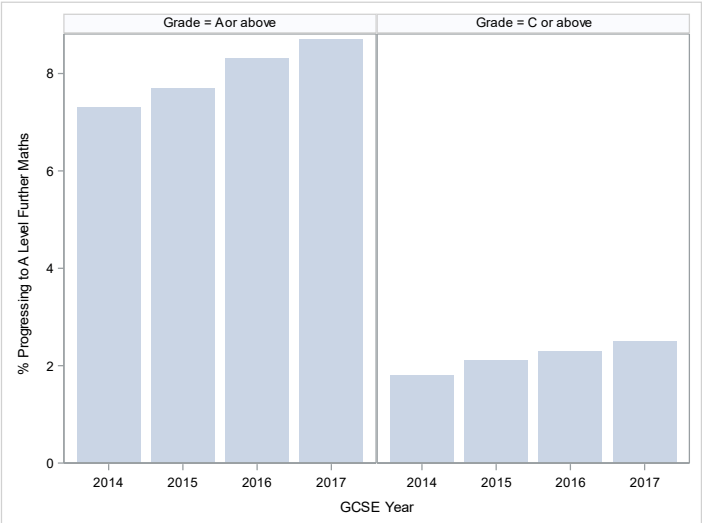
Progression to core maths and further maths by the individual GCSE grade is available in Table C5 in Appendix C.

Table 12: Progression to core maths and A level further maths, by achievement of GCSE grade thresholds (A/7 or above; C/4 or above)

	GCSE grade	GCSE	Core maths		A level further maths	
		N	N	%	N	%
Pre-reform (2014 – 2016)	A / 7 or above	293800	1482	0.5	22843	7.8
	C / 4 or above	1100647	5666	0.5	22954	2.1
Post-reform (2017)	A / 7 or above	106759	1168	1.1	9325	8.7
	C / 4 or above	376919	5052	1.3	9346	2.5



(a) Core maths



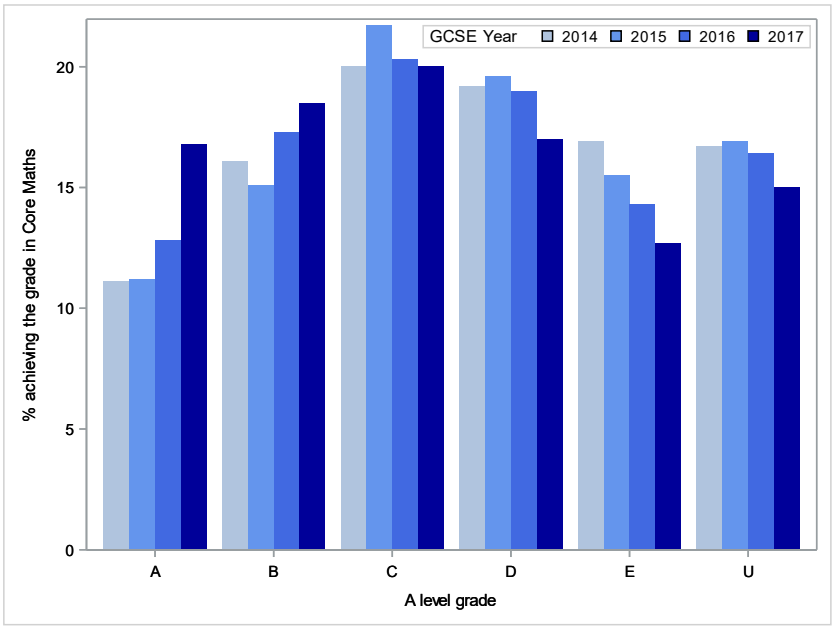
(b) A level further maths

Figure 9: Overall progression to specific level 3 maths qualifications, by GCSE year (pre-reform: 2014 to 2016; post-reform: 2017) and achievement of GCSE grade thresholds

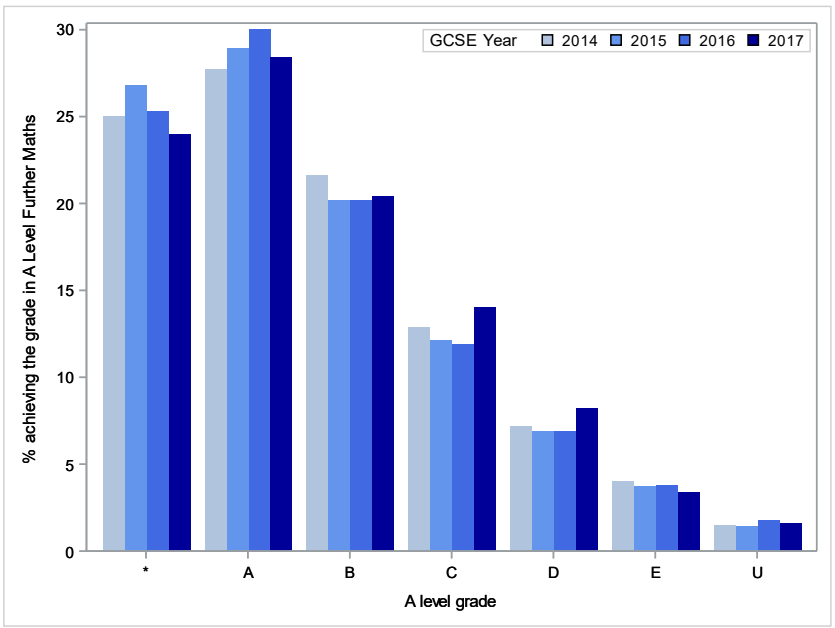
Performance in level 3 maths qualifications

Figure 10(a) (Table C6 in Appendix C) shows the core maths grade distribution for the cohorts of students progressing to core maths who achieved a GCSE in 2014 to 2016 (pre-reform) and in 2017 (post-reform). Compared to the pre-reform years (2014-2016), students who achieved a GCSE maths post-reform (2017) were more likely to achieve a grade A or a grade B in core maths. On the contrary, the percentages of students achieving grade D or E in core maths were lower post-reform. The percentage of students with grade U was also higher pre-reform.

Similarly, Figure 10(b) (Table C7 in Appendix C) shows the A level further maths grade distribution. In this case, compared to the pre-reform years (2014-2016), students who achieved a GCSE maths post-reform (2017) were less likely to achieve a grade A* or a grade A in A level further maths. On the contrary, the percentages of students achieving lower grades in A level further maths (*e.g.*, C or D) were higher post-reform.



(a) Core maths



(b) A level further maths

Figure 10: Grade distribution in level 3 Maths qualifications, by GCSE year (students progressing from GCSE maths)

Table 13 and Table 14 offer a more detailed view of the core maths and A level further maths grade distribution pre- and post-reform, breaking it down by GCSE grade. Note that only the achievement of grade thresholds (at least grade A; grade C or above) is shown.

For core maths, and looking at GCSE students who achieved, for example, grade A/7 in their maths GCSE, Table 13 shows that there were higher proportions of candidates achieving grade A in core maths post-reform than pre-reform.

For A level further maths, there was hardly any progression amongst candidates with a GCSE below grade A/7 (Table C5 in Appendix C). For candidates with up to and including a grade A/7 at GCSE, Table 14 shows that the percentage of students achieving at least grade A in A level further maths was lower post-reform. Table 14 also shows that the percentage of these students achieving at least grade C in A level further maths was also lower post-reform.

Table 13: Achievement of grade thresholds in core maths, by GCSE year and GCSE Maths grade

GCSE year	GCSE grade	Progressing to core maths	Core maths grade			
			Grade A		Grade C or above	
			N	%	N	%
2014	A*	16	12	75.0	16	100.0
	A	156	50	32.1	141	90.4
	B	518	62	6.6	283	54.6
	C or below	424			86	20.3
2015	A*	38	24	63.2	37	97.4
	A	429	140	32.6	369	86.0
	B	1423	149	10.5	793	55.7
	C or below	1006	12	1.2	190	18.9
2016	A*	71	51	71.8	69	97.2
	A	772	263	34.1	663	85.9
	B	2243	242	10.8	1272	56.7
	C or below	1389	15	1.1	247	17.8
2017	9	29	27	93.1	29	100.0
	8	239	163	68.2	234	97.9
	7	900	348	38.7	774	86.0
	6	1485	255	17.2	1038	69.9
	5	1752	59	2.4	661	37.7
	4 or below	677			73	10.8

Table 14: Achievement of grade thresholds in A level further maths, by GCSE year and GCSE Maths grade

GCSE year	GCSE grade	Progressing to A level further maths	A level further maths			
			Grade A or above		Grade C or above	
			N	%	N	%
2014	A*	5143	3050	59.3	4695	91.3
	A or below	996	176	17.7	660	66.3
2015	A*	7127	4361	61.2	6537	91.7
	A or below	1038	188	18.1	646	62.2
2016	A*	7504	4581	61.0	6873	91.6
	A or below	1153	206	17.9	693	60.1
2017	9	6546	4277	65.3	6150	94.0
	8	2409	589	24.4	1784	74.1
	7 or below	392	33	8.4	184	46.9

Regression analysis

Table 15 shows the results of the regression model looking at progression to any level 3 maths qualifications and Figure 11 (using data from Table 15) shows the probability of progressing to any level 3 maths qualification for a female student, of medium prior attainment, of medium level of deprivation, and in a comprehensive school.

Table 15 shows that the year the GCSE was taken was a statistically significant predictor of progression to any level 3 maths qualification, and its effect varied (significantly) by grade. For example:

- A candidate with grade 4 in GCSE maths, had a very similar (and very low) probability of progression pre- and post-reform.
- A candidate with grade 7 in GCSE maths, however, had lower probability of progression post-reform: a probability of 0.42 to progress to any level 3 maths qualification pre-reform (in 2015 as an example, but very similar for other pre-reform years) and a probability of 0.24 after the reform.

Figure 11 corroborates the above, showing that the probability of progression, although varying slightly by grade, was lower post-reform.

The results of the regression models looking, specifically, at progression to core maths and A level further maths are available in Tables C8 and C9 in Appendix C. In general, they support the results showed in Table 12 and Figure 9.

Table 15: Progression to any level 3 maths qualifications, regression analysis results (N = 1761038)

Variable		Estimate	Standard Error	Pr > |t|
Intercept		-12.329	0.044	<.0001
Gender	Male	0.884	0.007	<.0001
	[Female]	.	.	.
Deprivation	Medium	0.041	0.008	<.0001
	High	0.166	0.010	<.0001
	[Low]	.	.	.
Prior attainment	Medium	0.632	0.018	<.0001
	High	0.724	0.018	<.0001
	[Low]	.	.	.
School Type	Independent	-0.864	0.480	0.0717
	Other	-0.458	0.107	<.0001
	Secondary Modern	-0.070	0.058	0.2322
	Selective	-0.259	0.047	<.0001
	[Comprehensive]	.	.	.
GCSE Maths Grade		1.501	0.006	<.0001
GCSE Exam Year	2014	0.994	0.053	<.0001
	2015	1.218	0.050	<.0001
	2016	1.462	0.050	<.0001
	2017	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	-0.020	0.008	0.0106
	2015	-0.059	0.007	<.0001
	2016	-0.113	0.007	<.0001
	2017	.	.	.

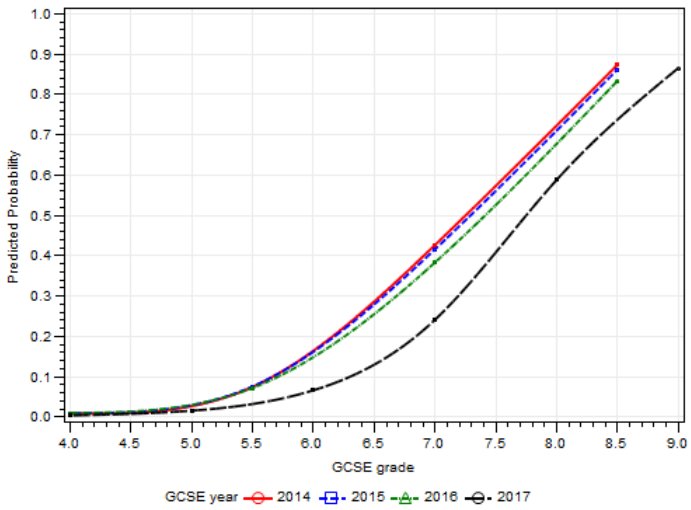
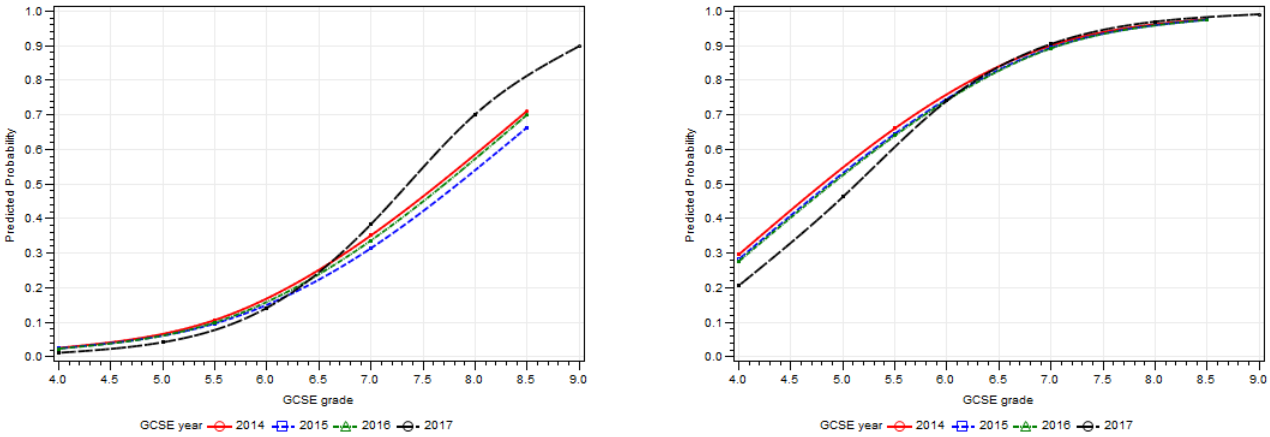


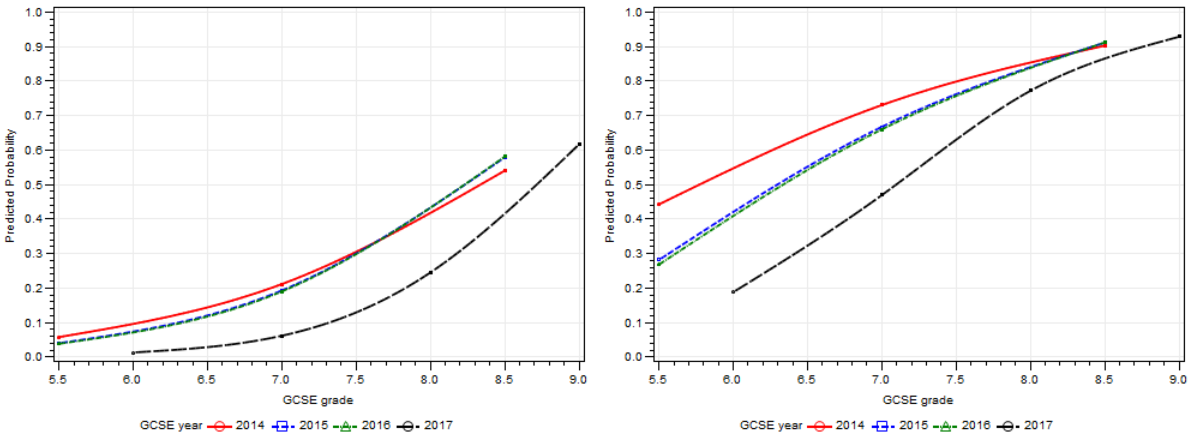
Figure 11: Probability of progression to any level 3 maths qualifications, by GCSE year and GCSE maths grade (Gender=Female; Prior attainment=Medium; Deprivation=Medium; School type=Comprehensive)

Figure 12 and Figure 13 below summarise the results of the regression analyses looking at the performance in core maths and in A level further maths (*i.e.*, probabilities of achieving specific thresholds) pre- and post-reform. Full results from the regression analyses are available in Tables C10 (core maths) and C11 (A level further maths), Appendix C.



(a) Grade A (b) Grade C or above

Figure 12: Probability of achieving a grade or above in core maths, by GCSE year and GCSE maths grade (Gender=Female; Prior attainment=High; Deprivation=Medium; School type=Comprehensive)



(a) Grade A or above (b) Grade C or above

Figure 13: Probability of achieving a grade or above in A level further maths, by GCSE year and GCSE maths grade (Gender=Male; Prior attainment=High; Deprivation=Medium; School type=Comprehensive)

For core maths, Figure 12 shows that the probability of achieving a grade A in core maths was similar pre- and post-reform for students with a GCSE maths grade below B. However, this probability was higher post-reform for students with top grades at GCSE. Achievement of grade C or above was lower post-reform for students with a GCSE maths grade below B, and similar pre- and post-reform for students with top GSCE grades.

For A level further maths, Figure 13 shows that the probability of achieving both grade A or above and grade C or above was lower post-reform than pre-reform across the GCSE grade range.

Progression to maths-related qualifications

In this section, progression from GCSE maths to level 3 maths-related qualifications was investigated. As described in the data and methods section, the category "maths-related" qualifications includes the following qualifications:

- A level biology
- A level chemistry
- A level physics
- A level economics
- A level psychology

Alongside results for progression to "any maths-related" qualifications, progression to and performance in each of the above A level subjects is reported separately.

Overall progression

Table 16, Figure 14 and Figure 15 (see Tables D2 and D4, respectively, in Appendix D for more details) show the progression to maths-related qualifications of students who achieved a GCSE in maths pre- and post-reform. These tables and figures show that progression to any maths-related subject was higher post-reform, overall and in each of the five A level subjects considered in this work. The difference between progression pre- and post-reform was highest in biology and chemistry (+2.1 percentage points) and lowest in economics (+0.5 percentage points).

For context, we also looked at progression to some non-maths-related subjects at A level (history, English literature, religious studies, sociology, and geography). Progression to A level in English literature and religious studies was generally lower post-reform. On the contrary, progression to history, sociology and geography was slightly higher post-reform. Differences between pre- and post- reform progression rates for these subjects were small, between 0.4 and 0.8 percentage points (these differences were smaller than for the science subjects in Table 16). Details of the analyses looking at progression to non-maths-related subjects can be found in Appendix E.

Table 16: Overall progression (%) to maths-related subjects, before and after the reform (Number of students in Table D1, Appendix D)

GCSE	Progression	Maths-related subjects (%)					
		Any subject	Biology	Chemistry	Physics	Economics	Psychology
Pre-reform (2014 – 2016)	No	79.8	92.7	94.3	96.1	96.6	91.5
	Yes	20.2	7.3	5.7	3.9	3.4	8.5
Post-reform (2017)	No	75.7	90.6	92.2	94.9	96.1	90.2
	Yes	24.3	9.4	7.8	5.1	3.9	9.8

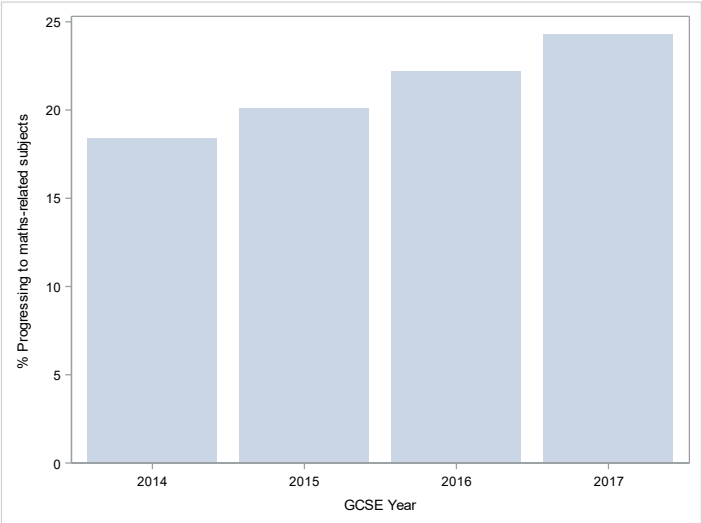
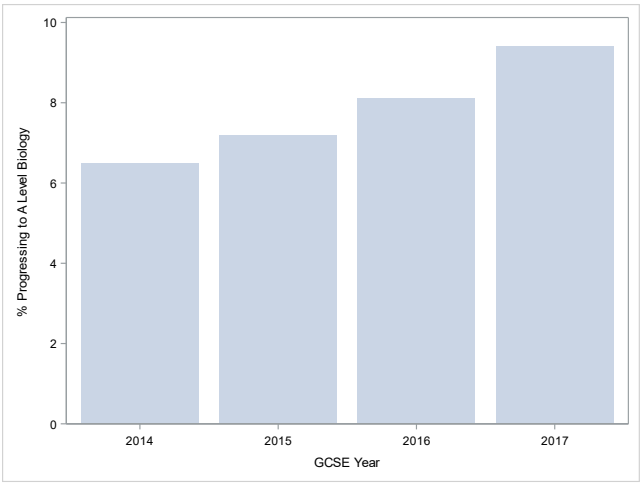
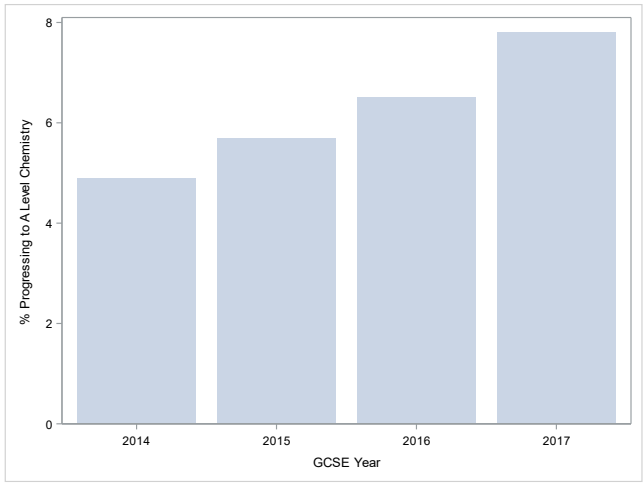


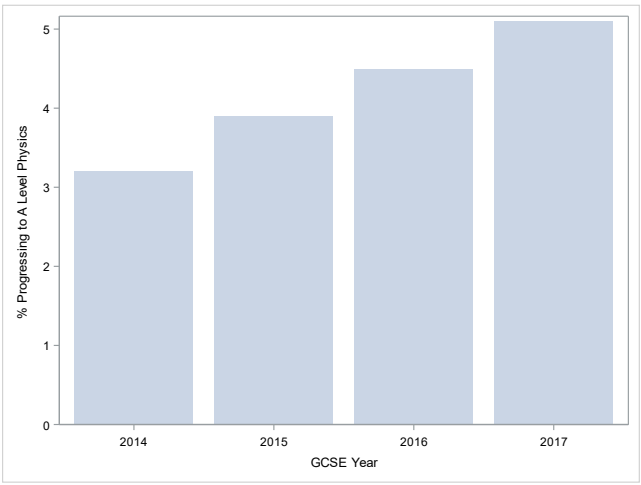
Figure 14: Overall progression to any maths-related A level subject, by GCSE year (pre-reform: 2014 to 2016; post-reform: 2017)



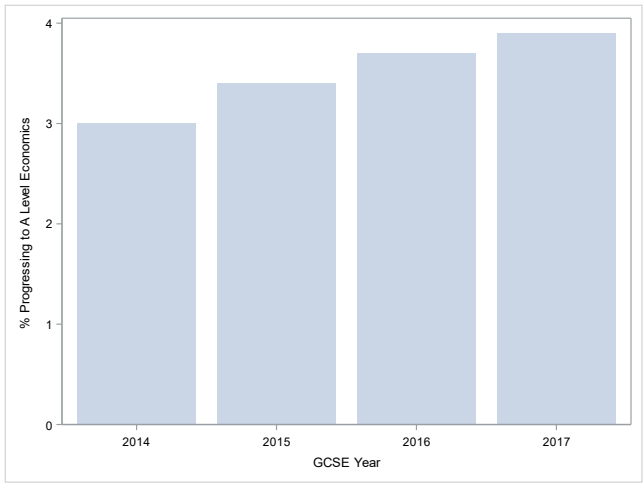
(a) A level Biology



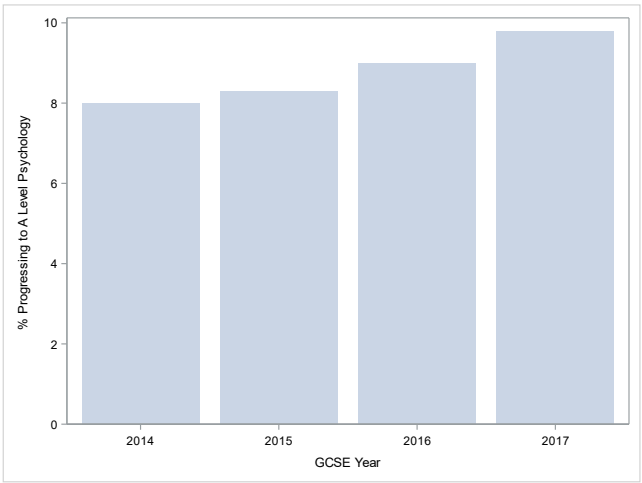
(b) A level Chemistry



(c) A level Physics



(d) A level Economics



(e) A level Psychology

Figure 15: Overall progression to maths-related subjects, by GCSE year (pre-reform: 2014 to 2016; post-reform: 2017)

Progression by GCSE grade

Any maths-related qualification

Table 17, Figure 16 and Figure 17 (see Tables D6 and D8, respectively, in Appendix D for more details) show the progression to maths-related qualifications broken down by achievement in the GCSE, pre- and post-reform.

Table 17: Progression to maths-related qualifications, by achievement of GCSE grade thresholds (Number of students in Table D5, Appendix D)

GCSE year	GCSE	Any subject	Biology	Chemistry	Physics	Economics	Psychology
Pre-reform (2014 – 2016)	A / 7 or above	61.1	25.5	24.5	18.0	10.9	14.6
	C / 4 or above	25.1	9.8	8.0	5.5	4.5	9.0
Post-reform (2017)	A /7 or above	68.0	29.1	29.9	21.9	11.6	14.8
	C /4 or above	34.0	13.2	10.9	7.2	5.4	13.6

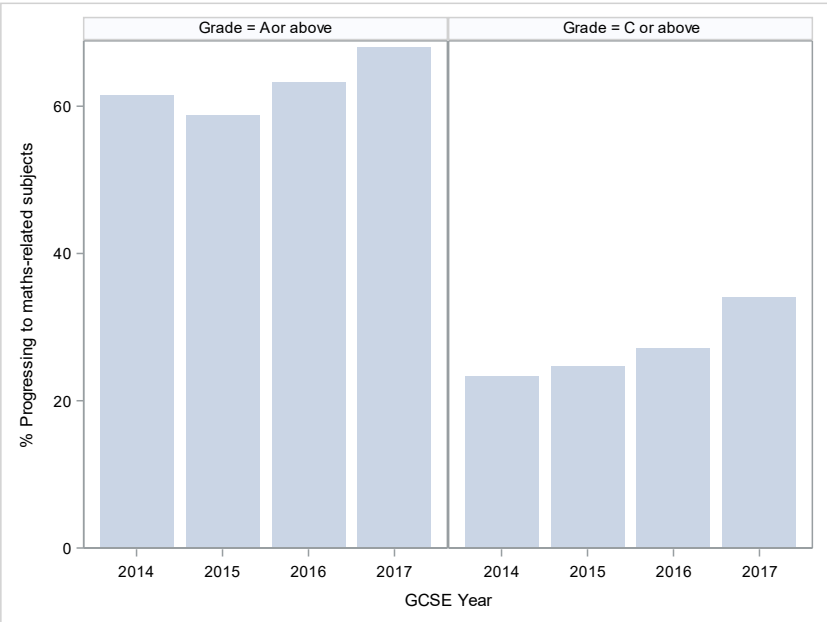
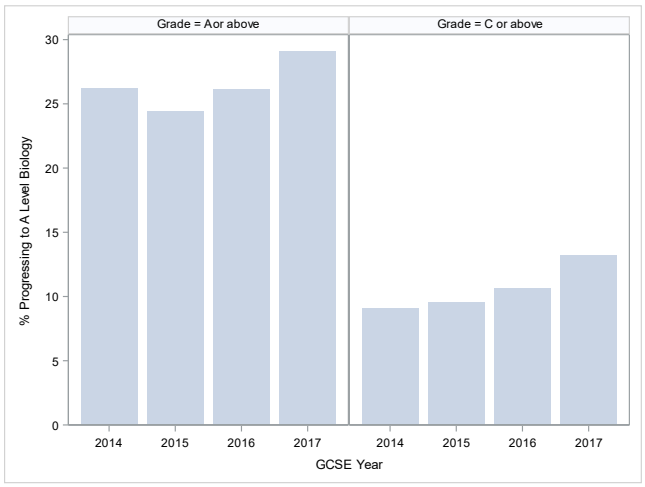
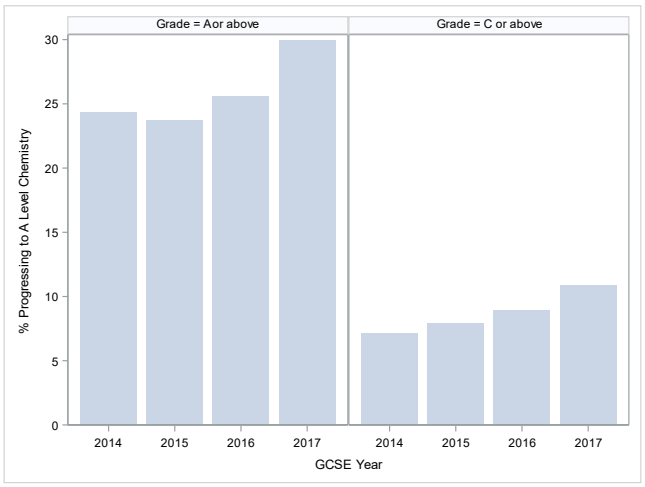


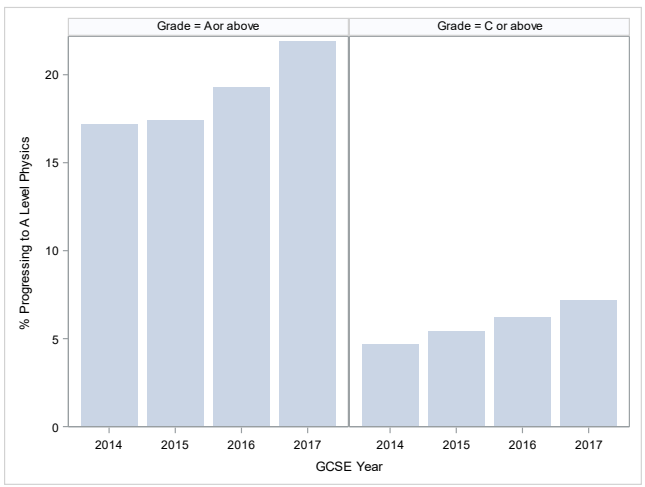
Figure 16: Overall progression to maths-related subjects, by GCSE year (pre-reform: 2014 to 2016; post-reform: 2017) and achievement of GCSE grade thresholds



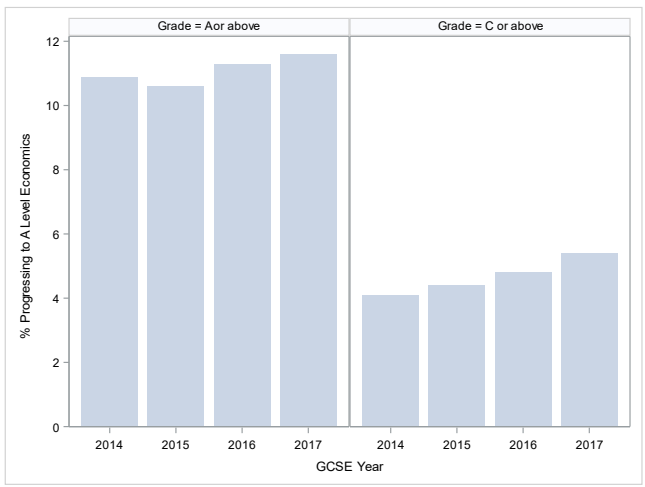
(a) A level Biology



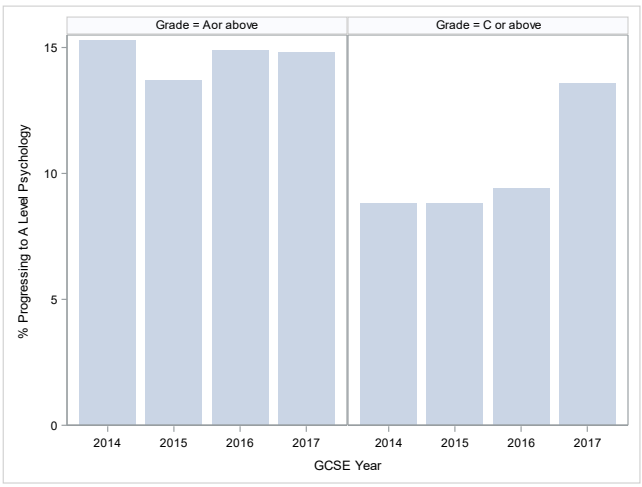
(b) A level Chemistry



(c) A level Physics



(d) A level Economics



(e) A level Psychology

Figure 17: Overall progression to maths-related subjects, by GCSE year (pre-reform: 2014 to 2016; post-reform: 2017) and achievement of GCSE grade thresholds

For all A level qualifications, progression increased post-reform for students who achieved at least grade A/7 in their GCSE maths. The highest increase in progression was for chemistry and physics (+5.4 and +3.9 percentage points, respectively) and the lowest increase was in psychology (+0.2 percentage points).

For students who achieved a grade C/4 or above, progression was also higher post-reform. The biggest increase was in psychology, followed by biology (+4.6 and +3.4 percentage points, respectively).

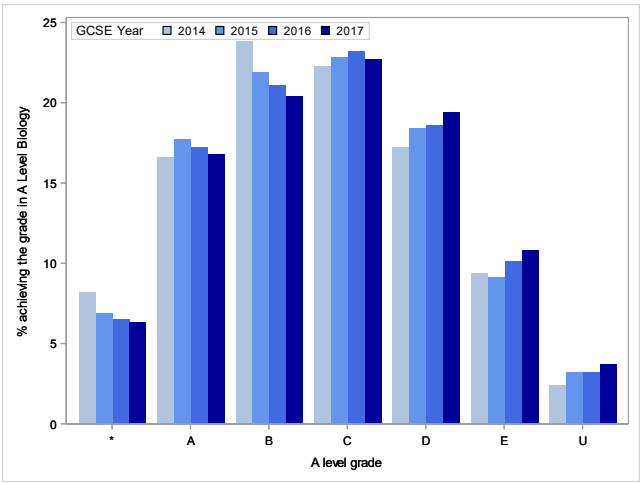
Progression to maths-related qualifications by individual grade can be found in Appendix D (Tables D9 to D11).

Performance in maths-related qualifications

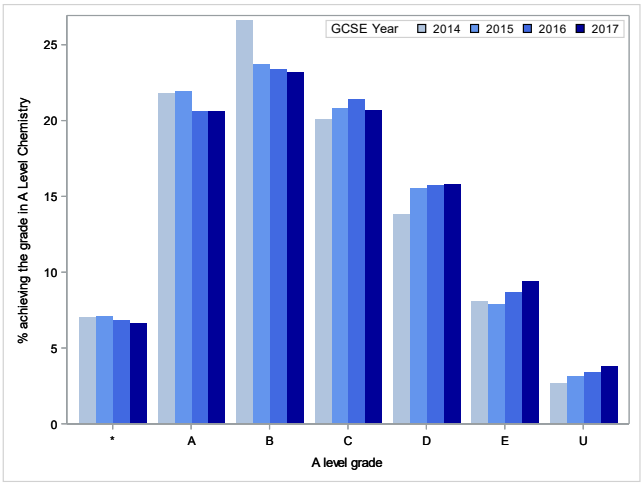
Figure 18 (and Tables D12 and D16 in Appendix D) shows the grade distribution in five maths-related A level subjects for the cohorts of students who achieved a GCSE in 2014 to 2016 (pre-reform) and in 2017 (post-reform).

Compared to the pre-reform years Figure 18 shows that, in general, performance in maths-related subjects was worse post-reform. In particular, the percentages of students achieving good grades (A*, A and B – with the exception of physics at grade B) were lower for students who achieved their GCSEs in 2017 (post-reform) than for students who achieved the qualification in previous years (2014-2016, pre-reform).

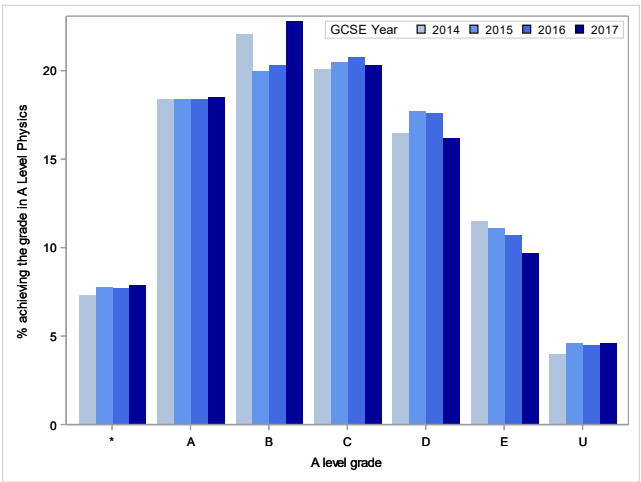
Table 18 and Table 19 offer a more detailed view of the grade distribution for the maths-related A level subjects pre- and post-reform, breaking it down by GCSE grade. Note that only the achievement of grade thresholds (at least grade A; at least grade C) is shown.



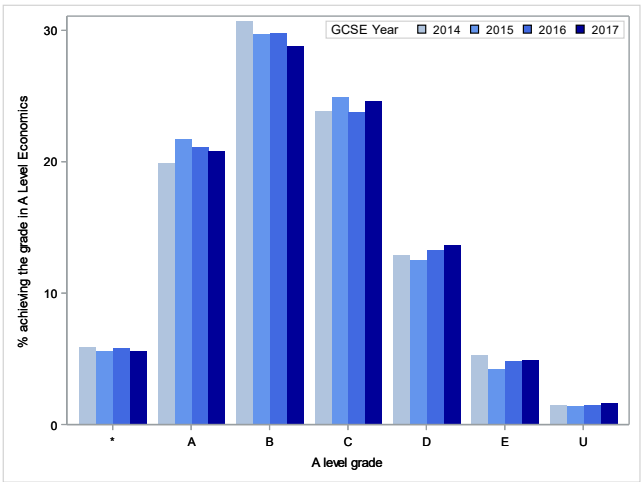
(a) A level Biology



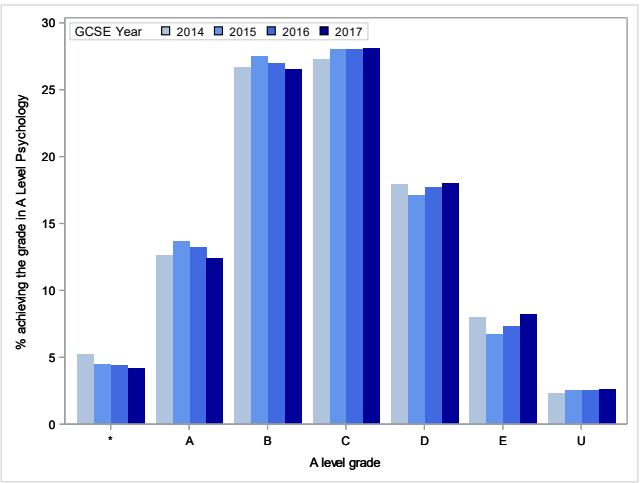
(b) A level Chemistry



(c) A level Physics



(d) A level Economics



(e) A level Psychology

Figure 18: Grade distribution in specific maths-related A levels, by GCSE year (students progressing from GCSE maths)

Table 18: Achievement of grade A or above in maths-related subjects, by GCSE year and GCSE maths grade (percentages were calculated using figures on progression to each subject, by GCSE grade, available in Table D10, Appendix D).

GCSE year	GCSE grade	Biology		Chemistry		Physics		Economics		Psychology	
		N	%	N	%	N	%	N	%	N	%
2014	A*	5093	57.4	5624	53.4	3672	44.7	1919	55.3	1392	52.0
	A	2576	19.8	1393	14.3	492	8.0	1458	25.8	2910	28.9
	B	509	5.5	153	3.3	28	1.5	526	10.5	2345	13.6
	C or below	26	1.4					48	3.9	592	5.5
2015	A*	6239	58.2	7123	53.6	4903	45.0	2379	54.7	1673	51.9
	A	2860	18.8	1697	14.4	592	7.9	1885	27.3	3413	30.1
	B	480	4.5	189	3.2	40	1.5	668	11.6	2596	13.5
	C or below	30	1.3					74	5.5	586	5.0
2016	A*	6371	57.9	7281	54.0	5306	47.0	2449	56.1	1835	55.0
	A	3172	19.5	1877	14.2	764	8.7	2004	27.0	3623	29.8
	B	482	3.9	210	2.8	39	1.2	739	11.7	2349	11.9
	C or below	22	0.8					66	4.5	443	3.8
2017	9	4078	73.3	5915	70.3	5064	63.6	1581	68.4	634	65.2
	8	4636	40.1	3912	31.8	1743	19.7	1850	41.6	2075	45.5
	7	2116	15.2	1149	10.3	278	4.2	1330	23.4	2744	26.7
	6	526	5.0	176	2.9	32	0.9	515	11.4	1890	14.5
	5	119	1.5	37	1.2			144	4.9	1051	6.9
	4 or below							20	3.0	224	2.8

Table 19: Achievement of grade C or above in maths-related subjects, by GCSE year and GCSE maths grade (percentages were calculated using figures on progression to each subject, by GCSE grade, available in Table D10, Appendix D).

GCSE year	GCSE grade	Biology		Chemistry		Physics		Economics		Psychology	
		N	%	N	%	N	%	N	%	N	%
2014	A*	8351	94.1	9870	93.6	7228	88.0	3301	95.1	2512	93.8
	A	9838	75.8	6915	70.9	3364	54.6	4776	84.7	8643	85.8
	B	4688	50.3	1883	45.5	448	24.8	3574	71.5	12378	71.7
	C or below	560	30.6	135	28.1	16	16.8	687	55.3	5695	53.2
2015	A*	10109	94.3	12306	92.6	9527	87.4	4164	95.7	3078	95.4
	A	11333	74.6	8135	68.9	3958	52.6	6020	87.2	9971	87.9
	B	5054	47.1	2246	42.7	597	23.6	4112	71.6	14174	73.9
	C or below	564	23.5	168	22.9	19	10.0	710	53.2	6240	53.6
2016	A*	10352	94.0	12504	92.8	10093	89.3	4178	95.7	3203	96.0
	A	12267	75.4	9307	70.2	4908	55.7	6371	86.0	10720	88.2
	B	5668	45.7	2691	40.8	704	22.8	4413	69.9	14344	72.5
	C or below	522	19.5	132	16.4	15	7.5	770	52.5	5818	49.6
2017	9	5434	97.6	8148	96.9	7741	97.3	2267	98.1	943	97.0
	8	10324	89.3	10655	86.5	7032	79.6	4154	93.4	4282	93.9
	7	9878	71.0	7264	65.0	3224	49.1	4744	83.6	8923	87.0
	6	5125	48.5	2470	40.3	667	24.2	3287	72.5	10007	76.6
	5	1885	29.1	652	24.5	84	9.8	1693	57.6	9383	61.8
	4 or below	217	13.3	60	12.2			272	40.9	3468	43.6

Regression analysis

To further explore the effect of GCSE reform on progression to and performance in maths-related qualifications, controlling for students' backgrounds (*e.g.*, gender; overall prior attainment; level of deprivation; school type), multilevel logistic regression analyses were carried out.

Table D17 in Appendix D shows the results of the regression model looking at progression to any maths-related qualifications and Tables D18 to D22 show the results of the models looking at progression to specific maths-related A level subjects. In all regression models, the year the GCSE was taken was a statistically significant predictor of progression, and its effect varied (significantly) by grade.

Figure 19 and Figure 20 (using data from the above tables) show the probability of progressing to any maths-related qualifications and individual A level subjects, for the "typical" student taking the qualification. Note that, when looking at the probability graphs in Figure 20, the Y-axis scale is not always the same.

These figures show that progression to any maths-related subject was higher post-reform, overall and in each of the five A level subjects considered in this work. This confirms the results from the descriptive analyses shown earlier. Note that, although progression to psychology was generally higher post-reform than pre-reform, it decreased with increasing GCSE maths grade in 2016 and 2017.

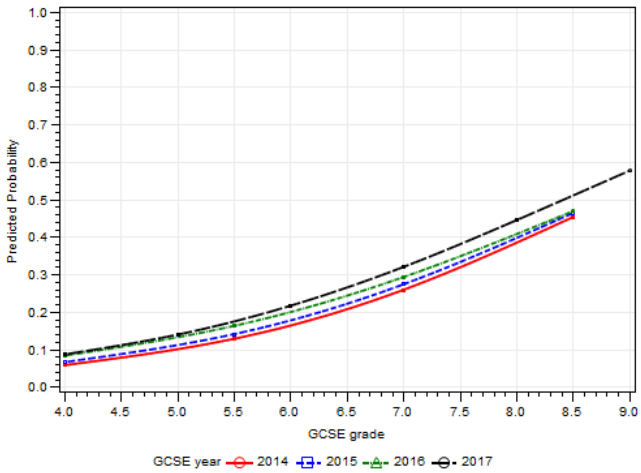
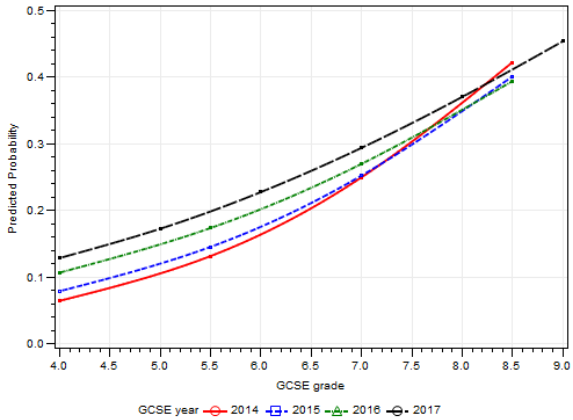
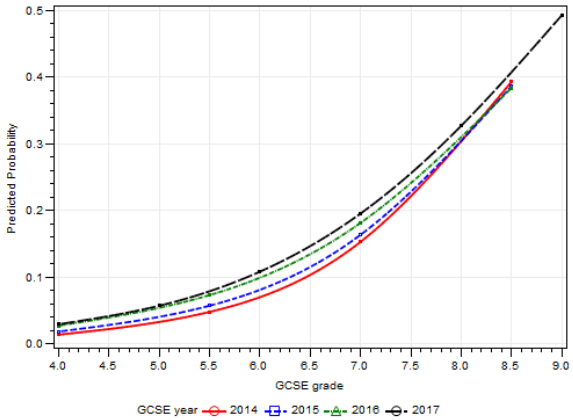


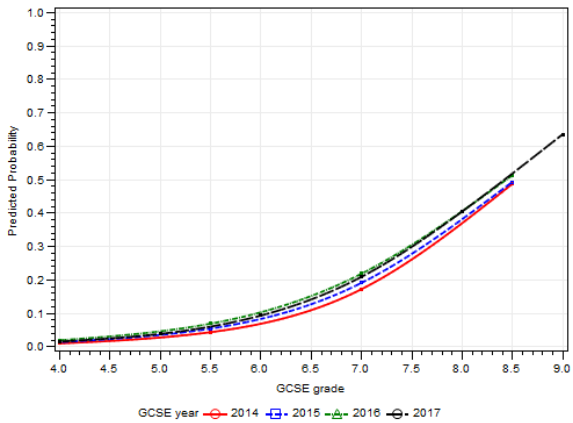
Figure 19: Probability of progression to any maths-related subject, by GCSE year and GCSE maths grade (Gender=Female; Prior attainment=Medium; Deprivation=Medium; School type=Comprehensive)



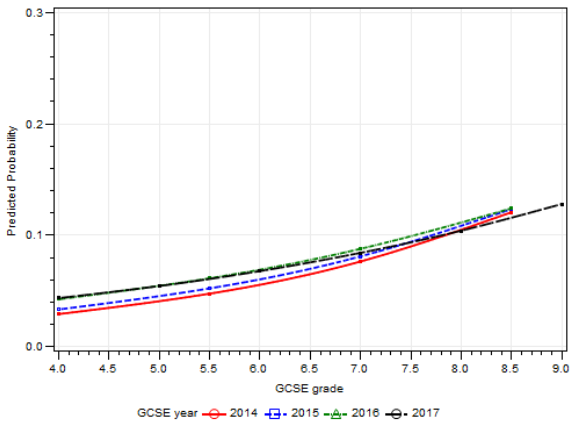
(a) A level Biology



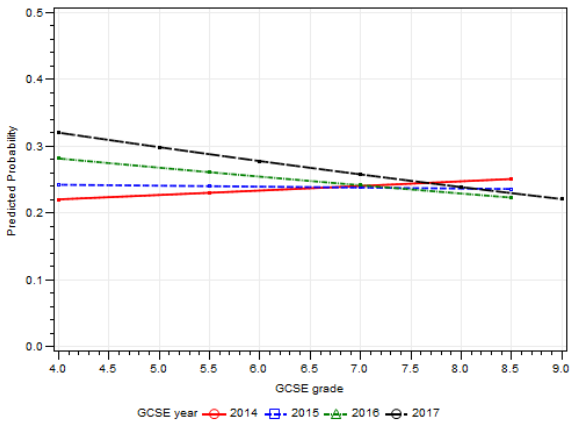
(b) A level Chemistry



(c) A level Physics



(d) A level Economics



(e) A level Psychology

Figure 20: Probability of progression to math-related subjects, by GCSE year and GCSE maths grade (for the “typical” student)[10]

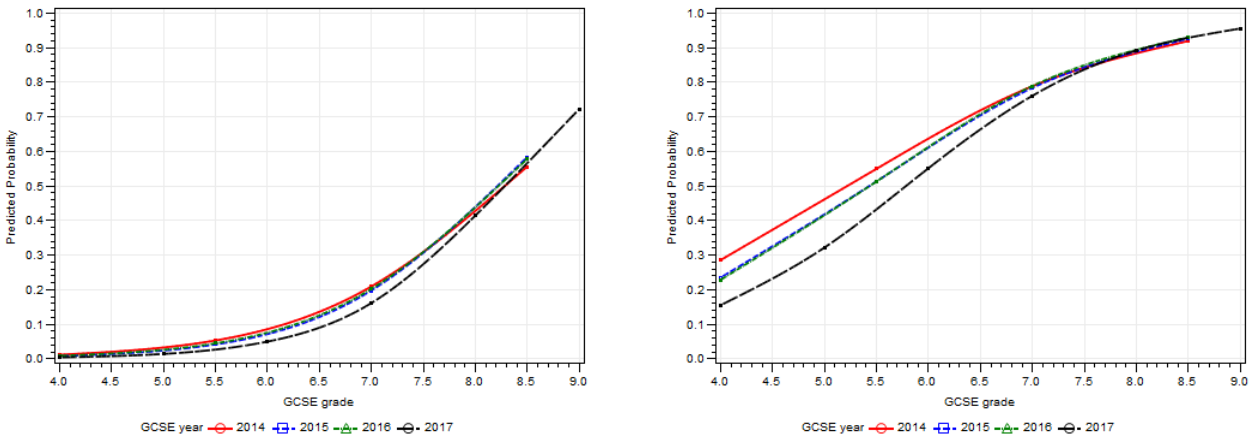
[10] Biology and Chemistry: Female; Prior attainment=High; Deprivation=Low; Comprehensive school
Physics: Male; Prior attainment=High; Deprivation=Low; Comprehensive school
Economics: Male; Prior attainment=High; Deprivation=Medium; comprehensive school
Psychology: Female; Prior attainment=High; Deprivation=Medium; Comprehensive school

Figure 21 to Figure 25 below summarise the results of the regression analyses looking at the performance in the different maths-related A levels (*i.e.*, probabilities of achieving specific thresholds) pre- and post-reform. The results of the regression models, from which the figures are derived, are presented in Tables D23 to D27 in Appendix D.

In all regression models, the year the GCSE was taken was a statistically significant predictor of performance, and its effect varied (significantly) by grade. In particular, as already shown by the descriptives analyses reported in the previous section, compared to the pre-reform years these figures show that, in general, performance in maths-related subjects was worse post-reform.

If we look at Figure 21 to Figure 23 (performance in A levels in biology, chemistry and physics) in a bit more detail, we can see that performance was very similar pre- and post-reform for students with the very top GCSE grades (with the exception of physics at grade A or above), but it was lower post-reform for students with lower grades in GCSE maths.

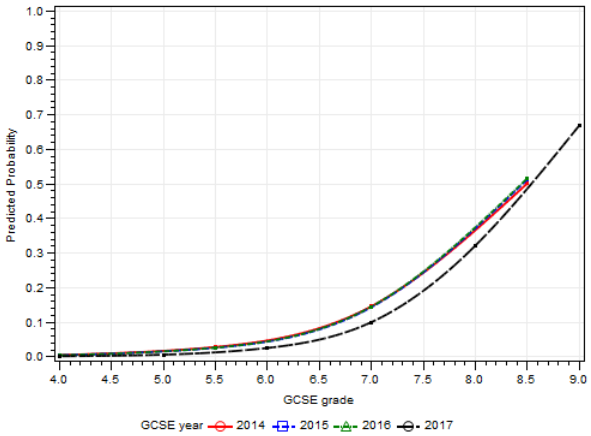
Figure 24 and Figure 25 show that performance in economics and psychology, although statistically significant different pre- and post-reform, was fairly similar in practice (both at grade A or above and at grade C or above).



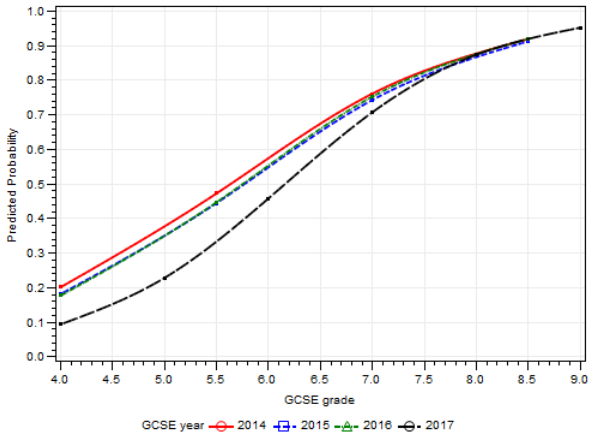
(a) Grade A or above

(b) Grade C or above

Figure 21: Probability of achieving a grade or above in A level Biology, by GCSE year and GCSE maths grade (Gender=Female; Prior attainment=High; Deprivation=Low; School type=Comprehensive)

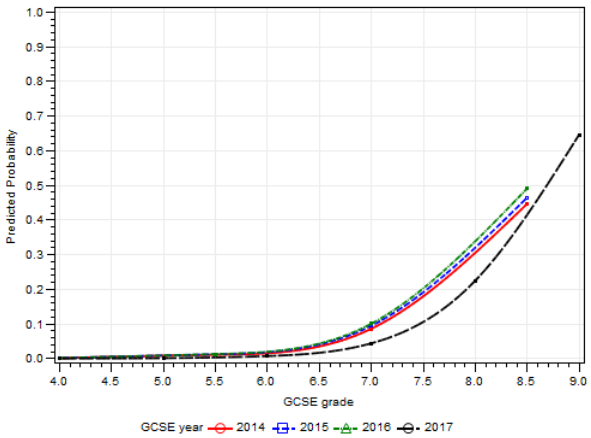


(a) Grade A or above

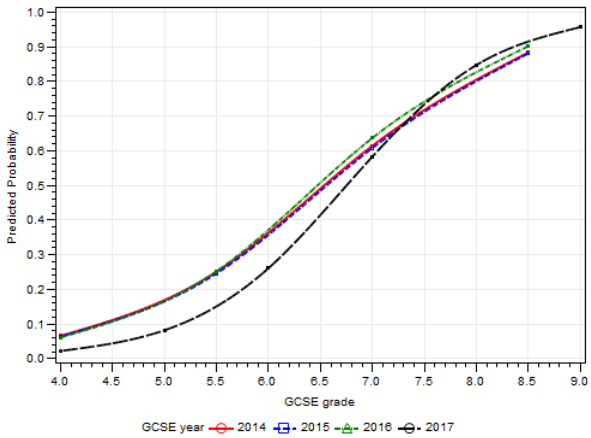


(b) Grade C or above

Figure 22: Probability of achieving a grade or above in A level Chemistry, by GCSE year and GCSE maths grade (Gender=Female; Prior attainment=High; Deprivation=Low; School type=Comprehensive)

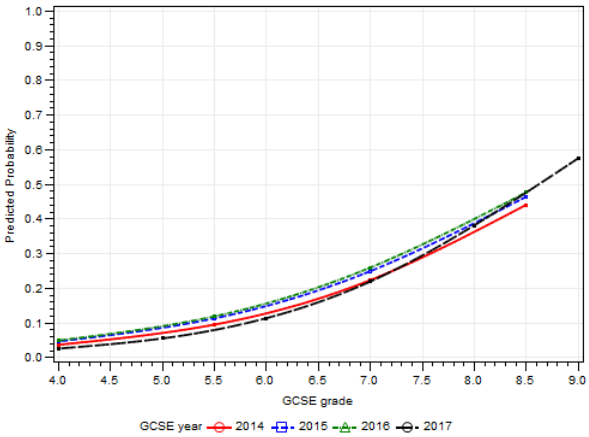


(a) Grade A or above

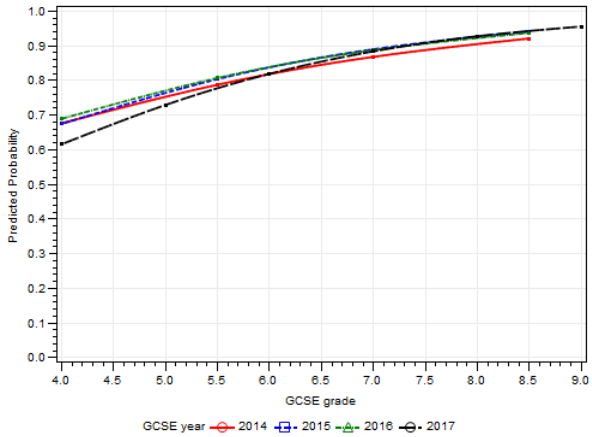


(b) Grade C or above

Figure 23: Probability of achieving a grade or above in A level Physics, by GCSE year and GCSE maths grade (Gender=Male; Prior attainment=High; Deprivation=Low; School type=Comprehensive)

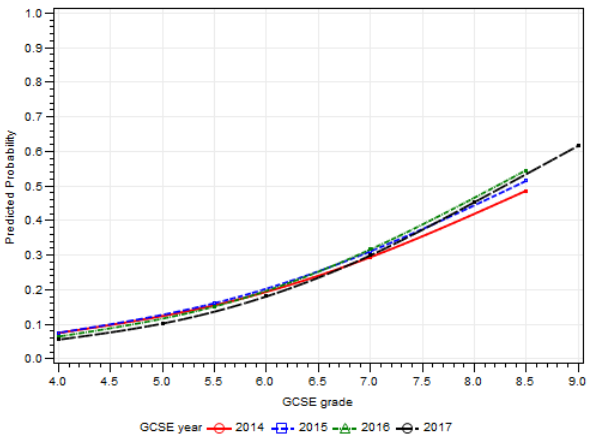


(a) Grade A or above

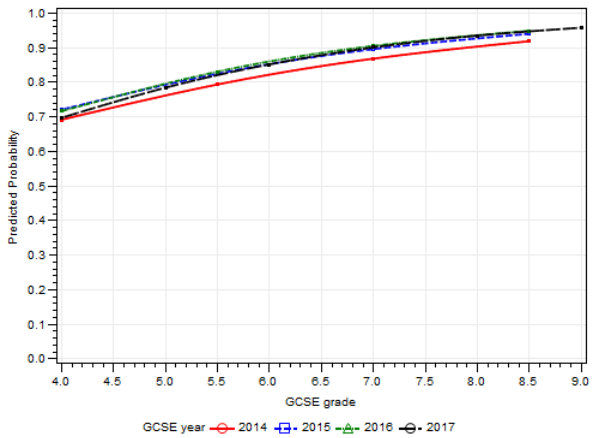


(b) Grade C or above

Figure 24: Probability of achieving a grade or above in A level Economics, by GCSE year and GCSE maths grade (Gender=Male; Prior attainment=High; Deprivation=Medium; School type=Comprehensive)



(a) Grade A or above



(b) Grade C or above

Figure 25: Probability of achieving a grade or above in A level Psychology, by GCSE year and GCSE maths grade (Gender=Female; Prior attainment=High; Deprivation=Medium; School type=Comprehensive)

Conclusions and discussion

This research has explored how well GCSE maths prepared young people for further study in mathematics and subjects with significant mathematical content in the context of GCSE reform. In the sections that follow, the findings of the research are summarised and discussed.

Progression to A level maths

Contrary to fears of reduction in the uptake of A level maths following the reform (*e.g.*, Lee *et al*., 2018; Redmond *et al*., 2020) this research showed that progression generally increased post-reform. However, when breaking it down by the grade achieved in GCSE maths, the increase in progression was higher amongst those who achieved at least grade A/7 than for students with at least grade C/4.

Performance in A level maths was, in general, lower post-reform. In particular, the probability of achieving at least grade A or at least grade C in A level maths was lower post-reform for students with any GCSE grade, apart from the students at the very top of the GCSE grade distribution. This contrasts with the perceptions of A level maths teachers interviewed in research by Howard and Khan (2019) or Humphries *at al*. (2017), who commented that the reformed GCSE prepared students for the A level at least as well, if not better, than the legacy GCSE and that students sitting the reformed GCSE would be leaving Key Stage 4 with more mathematical knowledge that previous cohorts. However, it should be taken into account that students taking the reformed GCSE would have also taken the newly reformed A level in maths, and it is well known that student performance tends to dip slightly in the first years of a new qualification (*i.e*., there is a sawtooth effect, as described, for example, in Cuff *et al*. (2019)). Whilst the approach to awarding and grading A levels in this context (comparable outcomes (Newton, 2020)) should have smoothed the sawtooth effect when looking at grade distributions, there could still be some evidence of relative under-performance. Furthermore, research showed that the reformed A level specifications were significantly more demanding than legacy specifications (Redmond *et al*., 2020), and there was concern from some teachers that while more able students may benefit from the more "aspirational" A level, lower performing students may be impacted negatively by the changes.

Progression to level 3 maths

Progression to level 3 maths (which included progression to AS level qualifications in maths and further maths, as well as progression to the A levels in those subjects) decreased post-reform. This decrease was present across the full GCSE grade range. A likely explanation of this result (in view of the increased progression to A level maths described above) is the decrease in the uptake of AS in maths in further maths in 2019, possibly due to A level reform and the decoupling of AS and A levels (see, for example, DfE (2020b) for evidence of the sharp decline of AS qualifications in recent years).

Progression to individual level 3 maths qualifications such as core maths or A level further maths increased post-reform (although it should be noted that progression to either of these qualifications was quite low both pre- and post-reform). In the case of core maths, as

suggested by Mathieson *et al*. (2020), this increase can be seen as the result of the opportunity that this subject provides students for whom there was previously no option to study maths post-16. There were, however, differences in progression by the grade achieved in GCSE maths: the increase was slightly lower amongst students who achieved at least grade A/7 than amongst students who achieved at least grade C/4 in core maths, whilst the opposite pattern was found for A level maths.

Regarding performance in core maths and A level further maths, compared to the pre-reform years, students who achieved a GCSE maths post-reform were more likely to achieve top grades (grades A or B) in core maths. On the contrary, compared to the pre-reform years, students who achieved a GCSE maths post-reform were less likely to achieve both grade A or above and grade C or above in A level further maths.

Progression to maths-related A level subjects

Howard and Khan (2019) reported that the reformed GCSE had positive implications beyond studying A level maths and that the new GCSE would support students' progression to and performance in other subjects with mathematical content. This research investigated the impact of GCSE maths reform on five maths-related A levels (biology, chemistry, physics, economics and psychology) and found that overall progression was higher post-reform in all subjects.

Compared to the pre-reform years, performance in maths-related subjects was generally worse post-reform. In particular, the A level science subjects (biology, chemistry and physics) performance was very similar pre- and post-reform for students with the very top GCSE grades in maths, but it was lower post-reform for students with lower grades in GCSE maths. However, in economics and psychology, performance was very similar pre- and post-reform.

This research is set in the context of recent reforms to GCSEs and A levels and, as with any reforms, changes take time to bed in. Given that this research focussed on the first year after the reform (the new GCSE maths was first assessed in 2017), it is possible that the results do not reflect how the reformed GCSE maths will impact progression to and performance in level 3 maths and maths-related subjects over the coming years.

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Appendix A: GCSE maths grade distributions

Table A1: GCSE maths grade distribution, pre-reform years

GCSE grade	Number of candidates				Percentage of candidates			
	2014	2015	2016	All Pre-reform	2014	2015	2016	All Pre-reform
A*	28043	39853	37179	105075	5.5	7.3	7.1	6.7
A	55386	66214	67125	188725	10.9	12.1	12.9	12.0
B	100264	110379	109433	320076	19.8	20.3	21.0	20.4
C	159102	168129	159540	486771	31.4	30.9	30.6	31.0
D	67703	77015	73543	218261	13.4	14.1	14.1	13.9
E	31396	28988	27042	87426	6.2	5.3	5.2	5.6
F	23436	19199	17170	59805	4.6	3.5	3.3	3.8
G	19450	16396	14278	50124	3.8	3.0	2.7	3.2
U	21182	18811	16462	56455	4.2	3.5	3.2	3.6
Total	*505962*	*544984*	*521772*	*1572718*				

Table A2: GCSE maths grade distribution, post-reform years

GCSE grade	2017 (Post-reform)	
	Number of candidates	Percentage of candidates
9	19145	3.6
8	35877	6.8
7	51737	9.8
6	59036	11.1
5	99787	18.8
4	111337	21.0
3	64957	12.2
2	46540	8.8
1	32220	6.1
U	9846	1.9
Total	*530482*	

Appendix B: Progression to A level maths

Table B1: Overall progression to A level maths

GCSE year	A level maths		
	Progression	N	%
2014	No	465271	92.0
	Yes	40691	8.0
2015	No	492946	90.5
	Yes	52038	9.5
2016	No	465586	89.2
	Yes	56186	10.8
2017	No	470651	88.7
	Yes	59831	11.3

Table B2: Progression to A level maths by GCSE grade

GCSE year	GCSE grade	GCSE	A level maths	
		N	N	%
2014	A/7 or above	83429	37047	44.4
	C/4 or above	342795	40614	11.8
2015	A/7 or above	106067	47634	44.9
	C/4 or above	384575	51931	13.5
2016	A/7 or above	104304	51165	49.1
	C/4 or above	373277	56111	15.0
2017	A/7 or above	106759	55174	51.7
	C/4 or above	376919	59822	15.9

Table B3: A level in maths grade distribution, for students progressing from GCSE maths (any grade)

GCSE year	Candidates	A level maths grade							All
		*	A	B	C	D	E	U	
2014	N	6216	9244	9418	7037	4874	2780	1122	40691
	%	15.3	22.7	23.1	17.3	12.0	6.8	2.8	
2015	N	8461	12200	11637	8860	5998	3364	1518	52038
	%	16.3	23.4	22.4	17.0	11.5	6.5	2.9	
2016	N	7765	14386	13086	9590	6083	3329	1947	56186
	%	13.8	25.6	23.3	17.1	10.8	5.9	3.5	
2017	N	9442	14498	10613	10272	8381	5062	1563	59831
	%	15.8	24.2	17.7	17.2	14.0	8.5	2.6	

Table B4: A level maths grade distribution, by GCSE year and GCSE maths grade (grade C/5 or above)

GCSE year	GCSE Maths grade	A level Maths grade							All
		*	A	B	C	D	E	U	
2014	A*	5505	6922	4538	2088	842	347	80	20322
	A	665	2171	4360	4138	3115	1670	606	16725
	B	45	148	511	802	902	748	411	3567
	C	17				13	15	25	70
2015	A*	7624	9272	5775	2764	1181	456	117	27189
	A	784	2761	5239	5065	3734	2034	828	20445
	B	52	164	606	1018	1063	859	535	4297
	C	28				19	12	36	95
2016	A*	7140	10608	6092	2500	1005	394	152	27891
	A	594	3568	6294	5952	3847	2039	980	23274
	B	28	206	692	1126	1219	889	786	4946
	C	22				12	32		66
2017	9	7640	6072	1848	790	291	79		16720
	8	1633	6764	5806	4638	2609	996	126	22572
	7	157	1513	2617	4111	4173	2669	642	15882
	6	143		323	693	1215	1203	640	4217
	5	13		14	39	91	117	136	410

Appendix C: Progression to Level 3 Maths qualifications

Table C1: Overall progression to any level 3 maths qualification

GCSE year	Level 3 maths (any)		
	Progression	N	%
2014	No	435555	86.1
	Yes	70407	13.9
2015	No	457764	84.0
	Yes	87220	16.0
2016	No	439657	84.3
	Yes	82115	15.7
2017	No	459752	86.7
	Yes	70730	13.3

Table C2: Overall progression, by level 3 maths qualification

GCSE year	Progression	Core maths		A level further maths	
		N	%	N	%
2014	No	504848	99.8	499823	98.8
	Yes	1114	0.2	6139	1.2
2015	No	542088	99.5	536819	98.5
	Yes	2896	0.5	8165	1.5
2016	No	517297	99.1	513115	98.3
	Yes	4475	0.9	8657	1.7
2017	No	525400	99.0	521135	98.2
	Yes	5082	1.0	9347	1.8

Table C3: Progression to any level 3 maths qualification, by GCSE grade

GCSE year	GCSE grade	GCSE	Level 3 maths (any)	
		N	N	%
2014	A/7 or above	83429	54392	65.2
	C/4 or above	342795	69154	20.2
2015	A/7 or above	106067	69840	65.8
	C/4 or above	384575	85388	22.2
2016	A/7 or above	104304	65712	63.0
	C/4 or above	373277	80289	21.5
2017	A/7 or above	106759	60464	56.6
	C/4 or above	376919	70688	18.8

Table C4: Progression to core maths and A level further maths, by GCSE grade

GCSE year	GCSE grade	GCSE	Core maths		A level further maths	
		N	N	%	N	%
2014	A/7 or above	83429	172	0.2	6095	7.3
	C/4 or above	342795	690	0.2	6137	1.8
2015	A/7 or above	106067	467	0.4	8129	7.7
	C/4 or above	384575	1890	0.5	8163	2.1
2016	A/7 or above	104304	843	0.8	8619	8.3
	C/4 or above	373277	3086	0.8	8654	2.3
2017	A/7 or above	106759	1168	1.1	9325	8.7
	C/4 or above	376919	5052	1.3	9346	2.5

Table C5: Progression to core maths and A level further maths by individual GCSE grade

GCSE year	GCSE grade	GCSE candidates	Progressing to core maths		Progressing to A level further maths	
			N	%	N	%
2014	A*	28043	16	0.1	5143	18.3
	A	55386	156	0.3	952	1.7
	B	100264	518	0.5	44	0.0
	C or below	322269	424	0.1		
2015	A*	39853	38	0.1	7127	17.9
	A	66214	429	0.6	1002	1.5
	B	110379	1423	1.3	36	0.0
	C or below	328538	1006	0.3		
2016	A*	37179	71	0.2	7504	20.2
	A	67125	772	1.2	1115	1.7
	B	109433	2243	2.0	38	0.0
	C or below	308035	1389	0.5		
2017	9	19145	29	0.2	6546	34.2
	8	35877	239	0.7	2409	6.7
	7	51737	900	1.7	370	0.7
	6	59036	1485	2.5	22	0.0
	5	99787	1752	1.8		
	4 or below	264900	677	0.3		

Table C6: Core maths grade distribution, for students progressing from GCSE maths (any grade)

GCSE year	Candidates	Core maths grade						All
		A	B	C	D	E	U	
2014	N	124	179	223	214	188	186	1114
	%	11.1	16.1	20.0	19.2	16.9	16.7	
2015	N	325	437	627	569	450	488	2896
	%	11.2	15.1	21.7	19.6	15.5	16.9	
2016	N	571	772	908	852	640	732	4475
	%	12.8	17.3	20.3	19.0	14.3	16.4	
2017	N	852	940	1017	866	646	761	5082
	%	16.8	18.5	20.0	17.0	12.7	15.0	

Table C7: A level further maths grade distribution, for students progressing from GCSE maths (any grade)

GCSE year	Candidates	A level further maths grade							All
		*	A	B	C	D	E	U	
2014	N	1537	1699	1325	794	441	248	95	6139
	%	25.0	27.7	21.6	12.9	7.2	4.0	1.5	
2015	N	2192	2357	1646	988	563	303	116	8165
	%	26.8	28.9	20.2	12.1	6.9	3.7	1.4	
2016	N	2188	2599	1751	1028	600	331	160	8657
	%	25.3	30.0	20.2	11.9	6.9	3.8	1.8	
2017	N	2246	2653	1909	1310	767	314	148	9347
	%	24.0	28.4	20.4	14.0	8.2	3.4	1.6	

Regression analyses

Table C8: Progression to core maths, regression analysis results (N = 1761038)

Variable		Estimate	Standard Error	Pr > |t|
Intercept		-7.648	0.067	<.0001
Gender	Male	0.497	0.021	<.0001
	[Female]	.	.	.
Deprivation	Medium	0.022	0.024	0.3610
	High	0.078	0.029	0.0063
	[Low]	.	.	.
Prior attainment	Medium	1.733	0.039	<.0001
	High	1.529	0.048	<.0001
	[Low]	.	.	.
School Type	Independent	-0.210	1.025	0.8374
	Other	-0.566	0.243	0.0200
	Secondary Modern	-0.221	0.155	0.1528
	Selective	-0.862	0.136	<.0001
	[Comprehensive]	.	.	.
GCSE Maths Grade		0.143	0.010	<.0001
GCSE Exam Year	2014	-1.296	0.116	<.0001
	2015	-0.221	0.081	0.0065
	2016	0.253	0.072	0.0004
	2017	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	-0.024	0.021	0.2477
	2015	-0.065	0.014	<.0001
	2016	-0.064	0.013	<.0001
	2017	.	.	.

Table C9: Progression to A level further maths, regression analysis results (N = 1761038)

Variable		Estimate	Standard Error	Pr > |t|
Intercept		-23.965	0.250	<.0001
Gender	Male	1.183	0.017	<.0001
	[Female]	.	.	.
Deprivation	Medium	0.020	0.017	0.2506
	High	0.026	0.022	0.2503
	[Low]	.	.	.
Prior attainment	Medium	3.055	0.184	<.0001
	High	3.206	0.180	<.0001
	[Low]	.	.	.
School Type	Independent	0.310	0.893	0.7285
	Other	-0.252	0.278	0.3648
	Secondary Modern	-0.529	0.092	<.0001
	Selective	-0.177	0.050	0.0004
	[Comprehensive]	.	.	.
GCSE Maths Grade		2.160	0.020	<.0001
GCSE Exam Year	2014	2.976	0.258	<.0001
	2015	2.150	0.254	<.0001
	2016	2.275	0.244	<.0001
	2017	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	-0.329	0.031	<.0001
	2015	-0.223	0.030	<.0001
	2016	-0.228	0.029	<.0001
	2017	.	.	.

Table C10: Achievement of grade thresholds in core maths, regression analysis results (N = 12140)

Variable		Grade A			At least Grade C		
		Estimate	Standard Error	Pr > |t|	Estimate	Standard Error	Pr > |t|
Intercept		-11.133	0.466	<.0001	-7.725	0.284	<.0001
Gender	Male	0.297	0.070	<.0001	0.350	0.052	<.0001
	[Female]	.	.	.	.	.	.
Deprivation	Medium	-0.150	0.076	0.0476	-0.134	0.057	0.0188
	High	-0.427	0.092	<.0001	-0.299	0.064	<.0001
	[Low]	.	.	.	.	.	.
Prior attainment	Medium	0.676	0.282	0.0165	0.787	0.112	<.0001
	High	1.525	0.282	<.0001	1.717	0.119	<.0001
	[Low]	.	.	.	.	.	.
School Type	Independent	-6.107	23.842	0.7978	4.548	26.927	0.8659
	Other	2.270	0.663	0.0006	0.708	0.563	0.2083
	Secondary Modern	-0.287	0.264	0.2778	-0.441	0.189	0.0196
	Selective	0.201	0.197	0.3084	0.397	0.187	0.0333
	[Comprehensive]	.	.	.	.	.	.
GCSE Maths Grade		1.326	0.058	<.0001	1.199	0.047	<.0001
GCSE Exam Year	2014	2.078	0.811	0.0104	1.189	0.535	0.0262
	2015	2.168	0.580	0.0002	1.128	0.391	0.004
	2016	1.959	0.504	0.0001	1.083	0.346	0.0018
	2017	.	.	.	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	-0.317	0.131	0.0153	-0.177	0.101	0.0800
	2015	-0.353	0.093	0.0001	-0.178	0.072	0.0137
	2016	-0.309	0.079	0.0001	-0.174	0.063	0.0058
	2017	.	.	.	.	.	.

Table C11: Achievement of grade thresholds in A level further maths, regression analysis results (N = 27386)

Variable		At least Grade A			At least Grade C		
		Estimate	Standard Error	Pr > |t|	Estimate	Standard Error	Pr > |t|
Intercept		-14.868	0.716	<.0001	-10.739	0.644	<.0001
Gender	Male	0.162	0.033	<.0001	0.132	0.047	0.0052
	[Female]	.	.	.	.	.	.
Deprivation	Medium	-0.207	0.032	<.0001	-0.299	0.047	<.0001
	High	-0.400	0.040	<.0001	-0.500	0.054	<.0001
	[Low]	.	.	.	.	.	.
Prior attainment	Medium	-0.578	0.550	0.2934	0.168	0.451	0.7094
	High	0.991	0.538	0.0653	1.398	0.445	0.0017
	[Low]	.	.	.	.	.	.
School Type	Independent	1.187	1.872	0.5258	-1.080	1.770	0.5417
	Other	-0.293	0.419	0.4834	0.057	0.536	0.9157
	Secondary Modern	-0.376	0.148	0.0110	-0.231	0.189	0.2215
	Selective	0.442	0.055	<.0001	0.440	0.082	<.0001
	[Comprehensive]	.	.	.	.	.	.
GCSE Maths Grade		1.599	0.054	<.0001	1.341	0.056	<.0001
GCSE Exam Year	2014	5.705	0.725	<.0001	4.776	0.691	<.0001
	2015	4.334	0.714	<.0001	2.581	0.666	0.0001
	2016	4.185	0.687	<.0001	2.384	0.639	0.0002
	2017	.	.	.	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	-0.614	0.085	<.0001	-0.523	0.084	<.0001
	2015	-0.434	0.084	<.0001	-0.252	0.081	0.0018
	2016	-0.416	0.080	<.0001	-0.228	0.078	0.0032
	2017	.	.	.	.	.	.

Appendix D: Progression to maths-related qualifications

Table D1: Overall progression (N) to maths-related subjects, before and after the reform

GCSE	Progression	Maths-related subjects (N)					
		Any subject	Biology	Chemistry	Physics	Economics	Psychology
Pre-reform (2014 – 2016)	No	1254321	1458309	1482597	1511905	1519477	1439614
	Yes	318397	114409	90121	60813	53241	133104
Post-reform (2017)	No	401536	480759	489295	503502	509917	478502
	Yes	128946	49723	41187	26980	20565	51980

Table D2: Overall progression to maths-related subjects

GCSE year	Maths-related subjects		
	Progression	N	%
2014	No	412987	81.6
	Yes	92975	18.4
2015	No	435427	79.9
	Yes	109557	20.1
2016	No	405907	77.8
	Yes	115865	22.2
2017	No	401536	75.7
	Yes	128946	24.3

Table D3: Overall progression (N), by maths-related subject

GCSE year	Progression	Maths-related subjects (N)				
		Biology	Chemistry	Physics	Economics	Psychology
2014	No	472953	481046	489693	490609	465235
	Yes	33009	24916	16269	15353	40727
2015	No	505941	513898	523837	526656	499595
	Yes	39043	31086	21147	18328	45389
2016	No	479415	487653	498375	502212	474784
	Yes	42357	34119	23397	19560	46988
2017	No	480759	489295	503502	509917	478502
	Yes	49723	41187	26980	20565	51980

Table D4: Overall progression (%), by maths-related subject (number of students in Table D3 above)

GCSE year	Progression	Maths-related subjects (%)				
		Biology	Chemistry	Physics	Economics	Psychology
2014	No	93.5	95.1	96.8	97.0	92.0
	Yes	6.5	4.9	3.2	3.0	8.0
2015	No	92.8	94.3	96.1	96.6	91.7
	Yes	7.2	5.7	3.9	3.4	8.3
2016	No	91.9	93.5	95.5	96.3	91.0
	Yes	8.1	6.5	4.5	3.7	9.0
2017	No	90.6	92.2	94.9	96.1	90.2
	Yes	9.4	7.8	5.1	3.9	9.8

Table D5: Progression to maths-related qualifications, by achievement of GCSE grade thresholds (A/7 or above; C/4 or above)

GCSE year	GCSE	GCSE	Any subject	Biology	Chemistry	Physics	Economics	Psychology
Pre-reform (2014 – 2016)	A /7 or above	293800	179484	75029	72115	52910	32144	42826
	C /4 or above	1100647	276279	107503	88103	60328	49199	99051
Post- reform (2017)	A / 7 or above	106759	72573	31047	31906	23368	12431	15796
	C / 4 or above	376919	128129	49635	41158	26975	20541	51246

Table D6: Overall progression to maths-related subjects (any), by GCSE grade

GCSE year	GCSE grade	GCSE	Maths-related subjects	
		N	N	%
2014	A /7 or above	83429	51205	61.4
	C /4 or above	342795	79967	23.3
2015	A / 7 or above	106067	62365	58.8
	C / 4 or above	384575	95162	24.7
2016	A /7 or above	104304	65914	63.2
	C /4 or above	373277	101150	27.1
2017	A / 7 or above	106759	72573	68.0
	C / 4 or above	376919	128129	34.0

Table D7: Overall progression (N) to individual maths-related subjects, by GCSE grade

GCSE year	GCSE grade	GCSE (N)	Maths-related subjects (N)				
			Biology	Chemistry	Physics	Economics	Psychology
2014	A /7 or above	83429	21851	20300	14369	9112	12757
	C /4 or above	342795	31177	24435	16174	14111	30032
2015	A / 7 or above	106067	25906	25089	18425	11253	14574
	C / 4 or above	384575	36644	30353	20957	16994	33751
2016	A /7 or above	104304	27272	26726	20116	11779	15495
	C /4 or above	373277	39682	33315	23197	18094	35268
2017	A / 7 or above	106759	31047	31906	23368	12431	15796
	C / 4 or above	376919	49635	41158	26975	20541	51246

Table D8: Overall progression (%) to individual maths-related subjects, by GCSE grade (number of students in Table D7 above)

GCSE year	GCSE grade	Maths-related subjects (%)				
		Biology	Chemistry	Physics	Economics	Psychology
2014	A /7 or above	26.2	24.3	17.2	10.9	15.3
	C /4 or above	9.1	7.1	4.7	4.1	8.8
2015	A / 7 or above	24.4	23.7	17.4	10.6	13.7
	C / 4 or above	9.5	7.9	5.4	4.4	8.8
2016	A /7 or above	26.1	25.6	19.3	11.3	14.9
	C /4 or above	10.6	8.9	6.2	4.8	9.4
2017	A / 7 or above	29.1	29.9	21.9	11.6	14.8
	C / 4 or above	13.2	10.9	7.2	5.4	13.6

Table D9: Progression to maths-related subjects (any) by individual GCSE grade (C/4 or above)

Reform	GCSE year	GCSE grade	GCSE candidates	Progressing to maths-related subjects	
				N	%
Pre-reform	2014	A*	28043	21314	76.0
		A	55386	29891	54.0
		B	100264	28762	28.7
		C	159102	12272	7.7
	2015	A*	39853	27106	68.0
		A	66214	35259	53.3
		B	110379	32797	29.7
		C	168129	13581	8.1
	2016	A*	37179	27662	74.4
		A	67125	38252	57.0
		B	109433	35236	32.2
		C	159540	13921	8.7
Post-reform	2017	9	19145	15793	82.5
		8	35877	26199	73.0
		7	51737	30581	59.1
		6	59036	25194	42.7
		5	99787	21709	21.8
		4	111337	8653	7.8

Table D10: Progression (N) to maths-related A level subjects by individual grade

GCSE year	GCSE grade	GCSE candidates	Maths-related subjects				
			Biology	Chemistry	Physics	Economics	Psychology
2014	A*	28043	8871	10541	8211	3471	2678
	A	55386	12980	9759	6158	5641	10079
	B	100264	9326	4135	1805	4999	17275
	C or below	322269	1832	481	95	1242	10695
2015	A*	39853	10722	13289	10902	4353	3225
	A	66214	15184	11800	7523	6900	11349
	B	110379	10738	5264	2532	5741	19177
	C or below	328538	2399	733	190	1334	11638
2016	A*	37179	11012	13471	11301	4368	3335
	A	67125	16260	13255	8815	7411	12160
	B	109433	12410	6589	3081	6315	19773
	C or below	308035	2675	804	200	1466	11719
2017	9	19145	5565	8411	7959	2310	972
	8	35877	11564	12313	8839	4449	4562
	7	51737	13918	11182	6570	5672	10262
	6	59036	10562	6124	2751	4532	13056
	5	99787	6487	2665	774	2937	15182
	4 or below	264900	1627	492	87	665	7946

Table D11: Progression (%) to specific maths-related subjects by individual GCSE grade (Number of students in Table D10 above)

GCSE year	GCSE grade	GCSE candidates	Maths-related subjects				
			Biology	Chemistry	Physics	Economics	Psychology
2014	A*	28043	31.6	37.6	29.3	12.4	9.5
	A	55386	23.4	17.6	11.1	10.2	18.2
	B	100264	9.3	4.1	1.8	5.0	17.2
	C or below	322269	0.6	0.1	0.0	0.4	3.3
2015	A*	39853	26.9	33.3	27.4	10.9	8.1
	A	66214	22.9	17.8	11.4	10.4	17.1
	B	110379	9.7	4.8	2.3	5.2	17.4
	C or below	328538	0.7	0.2	0.1	0.4	3.5
2016	A*	37179	29.6	36.2	30.4	11.7	9.0
	A	67125	24.2	19.7	13.1	11.0	18.1
	B	109433	11.3	6.0	2.8	5.8	18.1
	C or below	308035	0.9	0.3	0.1	0.5	3.8
2017	9	19145	29.1	43.9	41.6	12.1	5.1
	8	35877	32.2	34.3	24.6	12.4	12.7
	7	51737	26.9	21.6	12.7	11.0	19.8
	6	59036	17.9	10.4	4.7	7.7	22.1
	5	99787	6.5	2.7	0.8	2.9	15.2
	4 or below	264900	0.6	0.2	0.0	0.3	3.0

Table D12: A level biology grade distribution, for students progressing from GCSE maths (any grade)

GCSE year	Candidates	A level Biology grade							All
		*	A	B	C	D	E	U	
2014	N	2713	5491	7866	7367	5671	3096	805	33009
	%	8.2	16.6	23.8	22.3	17.2	9.4	2.4	
2015	N	2703	6906	8547	8904	7192	3549	1242	39043
	%	6.9	17.7	21.9	22.8	18.4	9.1	3.2	
2016	N	2745	7302	8956	9806	7894	4279	1375	42357
	%	6.5	17.2	21.1	23.2	18.6	10.1	3.2	
2017	N	3140	8335	10123	11265	9652	5349	1859	49723
	%	6.3	16.8	20.4	22.7	19.4	10.8	3.7	

Table D13: A level chemistry grade distribution, for students progressing from GCSE maths (any grade)

GCSE year	Candidates	A level Chemistry grade							All
		*	A	B	C	D	E	U	
2014	N	1748	5422	6629	5004	3427	2018	668	24916
	%	7.0	21.8	26.6	20.1	13.8	8.1	2.7	
2015	N	2209	6800	7382	6464	4825	2455	951	31086
	%	7.1	21.9	23.7	20.8	15.5	7.9	3.1	
2016	N	2325	7043	7971	7295	5370	2970	1145	34119
	%	6.8	20.6	23.4	21.4	15.7	8.7	3.4	
2017	N	2720	8469	9538	8522	6506	3885	1547	41187
	%	6.6	20.6	23.2	20.7	15.8	9.4	3.8	

Table D14: A level physics grade distribution, for students progressing from GCSE maths (any grade)

GCSE year	Candidates	A level Physics grade							All
		*	A	B	C	D	E	U	
2014	N	1191	3001	3589	3275	2689	1870	654	16269
	%	7.3	18.4	22.1	20.1	16.5	11.5	4.0	
2015	N	1641	3894	4238	4328	3733	2344	969	21147
	%	7.8	18.4	20.0	20.5	17.7	11.1	4.6	
2016	N	1800	4309	4753	4858	4117	2512	1048	23397
	%	7.7	18.4	20.3	20.8	17.6	10.7	4.5	
2017	N	2136	4981	6143	5488	4372	2615	1245	26980
	%	7.9	18.5	22.8	20.3	16.2	9.7	4.6	

Table D15: A level economics grade distribution, for students progressing from GCSE maths (any grade)

GCSE year	Candidates	A level Economics grade							All
		*	A	B	C	D	E	U	
2014	N	899	3052	4721	3666	1978	814	223	15353
	%	5.9	19.9	30.7	23.9	12.9	5.3	1.5	
2015	N	1022	3984	5441	4559	2294	776	252	18328
	%	5.6	21.7	29.7	24.9	12.5	4.2	1.4	
2016	N	1134	4124	5820	4654	2601	930	297	19560
	%	5.8	21.1	29.8	23.8	13.3	4.8	1.5	
2017	N	1155	4285	5919	5058	2816	1006	326	20565
	%	5.6	20.8	28.8	24.6	13.7	4.9	1.6	

Table D16: A level psychology grade distribution, for students progressing from GCSE maths (any grade)

GCSE year	Candidates	A level Psychology grade							All
		*	A	B	C	D	E	U	
2014	N	2125	5114	10875	11114	7310	3251	938	40727
	%	5.2	12.6	26.7	27.3	17.9	8.0	2.3	
2015	N	2048	6220	12487	12708	7759	3032	1135	45389
	%	4.5	13.7	27.5	28.0	17.1	6.7	2.5	
2016	N	2057	6193	12667	13168	8307	3410	1186	46988
	%	4.4	13.2	27.0	28.0	17.7	7.3	2.5	
2017	N	2194	6424	13798	14590	9346	4276	1352	51980
	%	4.2	12.4	26.5	28.1	18.0	8.2	2.6	

Regression analyses

Table D17: Progression to any maths-related qualification, regression analysis results (N = 1761038)

Variable		Estimate	Standard Error	Pr > |t|
Intercept		-7.654	0.035	<.0001
Gender	Male	-0.154	0.005	<.0001
	[Female]	.	.	.
Deprivation	Medium	-0.039	0.006	<.0001
	High	-0.026	0.008	0.0008
	[Low]	.	.	.
Prior attainment	Medium	3.229	0.028	<.0001
	High	4.559	0.029	<.0001
	[Low]	.	.	.
School Type	Independent	-0.737	0.315	0.0194
	Other	-1.183	0.100	<.0001
	Secondary Modern	-0.052	0.051	0.3081
	Selective	0.369	0.042	<.0001
	[Comprehensive]	.	.	.
GCSE Maths Grade		0.531	0.003	<.0001
GCSE Exam Year	2014	-0.598	0.029	<.0001
	2015	-0.378	0.027	<.0001
	2016	0.069	0.027	0.0101
	2017	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	0.043	0.005	<.0001
	2015	0.022	0.005	<.0001
	2016	-0.028	0.004	<.0001
	2017	.	.	.

Table D18: Progression to A level biology, regression analysis results (N = 1761038)

Variable		Estimate	Standard Error	Pr > |t|
Intercept		-8.648	0.081	<.0001
Gender	Male	-0.538	0.007	<.0001
	[Female]	.	.	.
Deprivation	Medium	0.013	0.008	0.0889
	High	0.064	0.010	<.0001
	[Low]	.	.	.
Prior attainment	Medium	3.551	0.078	<.0001
	High	5.357	0.078	<.0001
	[Low]	.	.	.
School Type	Independent	0.076	0.381	0.8422
	Other	-0.742	0.138	<.0001
	Secondary Modern	-0.030	0.048	0.5347
	Selective	0.215	0.036	<.0001
	[Comprehensive]	.	.	.
GCSE Maths Grade		0.345	0.004	<.0001
GCSE Exam Year	2014	-1.475	0.042	<.0001
	2015	-0.987	0.039	<.0001
	2016	-0.334	0.037	<.0001
	2017	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	0.179	0.006	<.0001
	2015	0.111	0.006	<.0001
	2016	0.031	0.006	<.0001
	2017	.	.	.

Table D19: Progression to A level chemistry, regression analysis results (N = 1761038)

Variable		Estimate	Standard Error	Pr > |t|
Intercept		-11.092	0.107	<.0001
Gender	Male	-0.056	0.008	<.0001
	[Female]	.	.	.
Deprivation	Medium	0.090	0.009	<.0001
	High	0.251	0.011	<.0001
	[Low]	.	.	.
Prior attainment	Medium	3.327	0.103	<.0001
	High	4.829	0.102	<.0001
	[Low]	.	.	.
School Type	Independent	-0.104	0.476	0.8267
	Other	-0.401	0.155	0.0099
	Secondary Modern	-0.146	0.060	0.0153
	Selective	0.104	0.045	0.0217
	[Comprehensive]	.	.	.
GCSE Maths Grade		0.693	0.005	<.0001
GCSE Exam Year	2014	-1.402	0.058	<.0001
	2015	-0.820	0.053	<.0001
	2016	-0.058	0.049	0.2386
	2017	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	0.158	0.008	<.0001
	2015	0.086	0.007	<.0001
	2016	-0.005	0.007	0.4917
	2017	.	.	.

Table D20: Progression to A level physics, regression analysis results (N = 1761038)

Variable		Estimate	Standard Error	Pr > |t|
Intercept		-13.811	0.112	<.0001
Gender	Male	1.830	0.011	<.0001
	[Female]	.	.	.
Deprivation	Medium	-0.024	0.011	0.0277
	High	-0.040	0.014	0.0041
	[Low]	.	.	.
Prior attainment	Medium	3.121	0.101	<.0001
	High	4.050	0.101	<.0001
	[Low]	.	.	.
School Type	Independent	0.241	0.505	0.6333
	Other	-0.542	0.171	0.0015
	Secondary Modern	-0.102	0.058	0.0774
	Selective	0.014	0.040	0.7191
	[Comprehensive]	.	.	.
GCSE Maths Grade		0.943	0.007	<.0001
GCSE Exam Year	2014	-0.728	0.081	<.0001
	2015	-0.118	0.073	0.1071
	2016	0.468	0.069	<.0001
	2017	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	0.070	0.011	<.0001
	2015	0.001	0.010	0.9405
	2016	-0.059	0.009	<.0001
	2017	.	.	.

Table 21: Progression to A level economics, regression analysis results (N = 1761038)

Variable		Estimate	Standard Error	Pr > |t|
Intercept		-9.448	0.076	<.0001
Gender	Male	1.173	0.011	<.0001
	[Female]	.	.	.
Deprivation	Medium	-0.110	0.011	<.0001
	High	-0.112	0.015	<.0001
	[Low]	.	.	.
Prior attainment	Medium	3.453	0.066	<.0001
	High	4.364	0.066	<.0001
	[Low]	.	.	.
School Type	Independent	0.172	0.550	0.7543
	Other	-0.904	0.224	<.0001
	Secondary Modern	-0.211	0.109	0.053
	Selective	0.889	0.084	<.0001
	[Comprehensive]	.	.	.
GCSE Maths Grade		0.234	0.006	<.0001
GCSE Exam Year	2014	-0.824	0.055	<.0001
	2015	-0.589	0.052	<.0001
	2016	-0.120	0.050	0.0164
	2017	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	0.103	0.008	<.0001
	2015	0.078	0.008	<.0001
	2016	0.024	0.007	0.0013
	2017	.	.	.

Table 22: Progression to A level psychology, regression analysis results (N = 1761038)

Variable		Estimate	Standard Error	Pr > |t|
Intercept		-5.508	0.039	<.0001
Gender	Male	-1.071	0.007	<.0001
	[Female]	.	.	.
Deprivation	Medium	-0.010	0.007	0.1570
	High	-0.022	0.009	0.0146
	[Low]	0.000	.	.
Prior attainment	Medium	3.891	0.035	<.0001
	High	5.171	0.036	<.0001
	[Low]	.	.	.
School Type	Independent	-1.240	0.521	0.0172
	Other	-1.377	0.128	<.0001
	Secondary Modern	0.083	0.049	0.0927
	Selective	-0.101	0.040	0.0125
	[Comprehensive]	.	.	.
GCSE Maths Grade		-0.102	0.003	<.0001
GCSE Exam Year	2014	-1.066	0.030	<.0001
	2015	-0.762	0.028	<.0001
	2016	-0.313	0.028	<.0001
	2017	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	0.139	0.005	<.0001
	2015	0.094	0.005	<.0001
	2016	0.032	0.005	<.0001
	2017	.	.	.

Table D23: Achievement of grade thresholds in A level biology, regression analysis results (N = 138435)

Variable		At least Grade A			At least Grade C		
		Estimate	Standard Error	Pr > |t|	Estimate	Standard Error	Pr > |t|
Intercept		-11.158	0.637	<.0001	-7.281	0.312	<.0001
Gender	Male	-0.046	0.017	0.0081	0.050	0.016	0.0013
	[Female]	.	.	.	.	.	.
Deprivation	Medium	-0.203	0.018	<.0001	-0.169	0.017	<.0001
	High	-0.390	0.023	<.0001	-0.241	0.020	<.0001
	[Low]	.	.	.	.	.	.
Prior attainment	Medium	-1.619	0.636	0.0108	0.463	0.304	0.1280
	High	0.396	0.626	0.5267	1.786	0.303	<.0001
	[Low]	.	.	.	.	.	.
School Type	Independent	2.271	0.951	0.0170	1.304	0.941	0.1659
	Other	-0.095	0.309	0.7597	0.198	0.260	0.4467
	Secondary Modern	-0.327	0.081	<.0001	-0.212	0.068	0.0017
	Selective	0.395	0.043	<.0001	0.247	0.046	<.0001
	[Comprehensive]	.	.	.	.	.	.
GCSE Maths Grade		1.302	0.016	<.0001	0.950	0.012	<.0001
GCSE Exam Year	2014	2.184	0.178	<.0001	1.605	0.117	<.0001
	2015	1.250	0.174	<.0001	1.028	0.112	<.0001
	2016	1.513	0.167	<.0001	0.900	0.108	<.0001
	2017	.	.	.	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	-0.266	0.023	<.0001	-0.207	0.018	<.0001
	2015	-0.143	0.023	<.0001	-0.128	0.017	<.0001
	2016	-0.177	0.022	<.0001	-0.105	0.016	<.0001
	2017	.	.	.	.	.	.

Table D24: Achievement of grade thresholds in A level chemistry, regression analysis results (N = 110988)

Variable		At least Grade A			At least Grade C		
		Estimate	Standard Error	Pr > |t|	Estimate	Standard Error	Pr > |t|
Intercept		-11.800	0.488	<.0001	-6.898	0.297	<.0001
Gender	Male	0.143	0.018	<.0001	0.034	0.017	0.0485
	[Female]	.	.	.	.	.	.
Deprivation	Medium	-0.210	0.020	<.0001	-0.171	0.020	<.0001
	High	-0.347	0.024	<.0001	-0.254	0.023	<.0001
	[Low]	0.000	.	.	0.000	.	.
Prior attainment	Medium	-2.190	0.476	<.0001	-0.608	0.283	0.0319
	High	-0.534	0.466	0.2512	0.433	0.282	0.1247
	[Low]	.	.	.	.	.	.
School Type	Independent	2.297	1.190	0.0535	0.961	1.049	0.3596
	Other	0.073	0.305	0.8095	0.469	0.273	0.0863
	Secondary Modern	-0.549	0.092	<.0001	-0.316	0.078	<.0001
	Selective	0.309	0.044	<.0001	0.249	0.049	<.0001
	[Comprehensive]	.	.	.	.	.	.
GCSE Maths Grade		1.448	0.019	<.0001	1.049	0.014	<.0001
GCSE Exam Year	2014	2.297	0.236	<.0001	1.706	0.156	<.0001
	2015	1.978	0.221	<.0001	1.539	0.142	<.0001
	2016	1.982	0.211	<.0001	1.399	0.136	<.0001
	2017	.	.	.	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	-0.267	0.029	<.0001	-0.204	0.022	<.0001
	2015	-0.224	0.027	<.0001	-0.194	0.020	<.0001
	2016	-0.223	0.026	<.0001	-0.167	0.019	<.0001
	2017	.	.	.	.	.	.

Table D25: Achievement of grade thresholds in A level physics, regression analysis results (N = 74317)

Variable		At least Grade A			At least Grade C		
		Estimate	Standard Error	Pr > |t|	Estimate	Standard Error	Pr > |t|
Intercept		-14.827	0.552	<.0001	-9.906	0.350	<.0001
Gender	Male	0.237	0.027	<.0001	0.255	0.026	<.0001
	[Female]	.	.	.	.	.	.
Deprivation	Medium	-0.198	0.024	<.0001	-0.166	0.023	<.0001
	High	-0.465	0.031	<.0001	-0.310	0.028	<.0001
	[Low]	.	.	.	.	.	.
Prior attainment	Medium	-3.073	0.511	<.0001	-0.759	0.317	0.0167
	High	-1.362	0.500	0.0064	0.357	0.316	0.2586
	[Low]	.	.	.	.	.	.
School Type	Independent	-3.394	8.823	0.7005	-0.282	1.059	0.7904
	Other	-0.031	0.344	0.9278	0.890	0.331	0.0071
	Secondary Modern	-0.529	0.105	<.0001	-0.374	0.089	<.0001
	Selective	0.384	0.046	<.0001	0.270	0.052	<.0001
	[Comprehensive]	.	.	.	.	.	.
GCSE Maths Grade		1.839	0.029	<.0001	1.375	0.021	<.0001
GCSE Exam Year	2014	3.572	0.394	<.0001	2.479	0.236	<.0001
	2015	3.818	0.357	<.0001	2.457	0.214	<.0001
	2016	3.713	0.334	<.0001	2.164	0.207	<.0001
	2017	.	.	.	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	-0.408	0.047	<.0001	-0.335	0.032	<.0001
	2015	-0.429	0.043	<.0001	-0.336	0.029	<.0001
	2016	-0.404	0.040	<.0001	-0.277	0.028	<.0001
	2017	.	.	.	.	.	.

Table D26: Achievement of grade thresholds in A level economics, regression analysis results (N = 60940)

Variable		At least Grade A			At least Grade C		
		Estimate	Standard Error	Pr > |t|	Estimate	Standard Error	Pr > |t|
Intercept		-8.181	0.515	<.0001	-3.706	0.198	<.0001
Gender	Male	-0.106	0.025	<.0001	0.117	0.028	<.0001
	[Female]	.	.	.	.	.	.
Deprivation	Medium	-0.187	0.026	<.0001	-0.193	0.029	<.0001
	High	-0.390	0.033	<.0001	-0.360	0.033	<.0001
	[Low]	.	.	.	0.000	.	.
Prior attainment	Medium	-0.024	0.499	0.9617	0.841	0.163	<.0001
	High	1.713	0.496	0.0006	2.181	0.164	<.0001
	[Low]	.	.	.	.	.	.
School Type	Independent	1.261	1.119	0.2599	-0.795	1.239	0.5209
	Other	0.486	0.367	0.1854	1.097	0.557	0.0487
	Secondary Modern	-0.497	0.116	<.0001	-0.350	0.107	0.0011
	Selective	0.328	0.050	<.0001	0.285	0.063	<.0001
	[Comprehensive]	.	.	.	.	.	.
GCSE Maths Grade		0.785	0.019	<.0001	0.518	0.019	<.0001
GCSE Exam Year	2014	0.817	0.215	0.0001	0.813	0.171	<.0001
	2015	1.193	0.199	<.0001	0.515	0.166	0.0019
	2016	1.261	0.194	<.0001	0.709	0.159	<.0001
	2017	.	.	.	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	-0.113	0.029	<.0001	-0.137	0.027	<.0001
	2015	-0.147	0.027	<.0001	-0.065	0.026	0.0135
	2016	-0.149	0.026	<.0001	-0.096	0.025	0.0001
	2017	.	.	.	.	.	.

Table D27: Achievement of grade thresholds in A level psychology, regression analysis results (N = 157692)

Variable		At least Grade A			At least Grade C		
		Estimate	Standard Error	Pr > |t|	Estimate	Standard Error	Pr > |t|
Intercept		-7.413	0.383	<.0001	-3.284	0.112	<.0001
Gender	Male	-0.719	0.021	<.0001	-0.536	0.015	<.0001
	[Female]	.	.	.	.	.	.
Deprivation	Medium	-0.110	0.018	<.0001	-0.121	0.016	<.0001
	High	-0.283	0.023	<.0001	-0.202	0.019	<.0001
	[Low]	.	.	.	.	.	.
Prior attainment	Medium	0.013	0.378	0.9726	0.952	0.098	<.0001
	High	2.038	0.376	<.0001	2.413	0.098	<.0001
	[Low]	.	.	.	.	.	.
School Type	Independent	-4.413	12.649	0.7272	0.349	1.332	0.7934
	Other	0.461	0.302	0.1267	0.640	0.274	0.0196
	Secondary Modern	-0.116	0.071	0.1055	-0.203	0.064	0.0015
	Selective	0.133	0.050	0.0083	0.068	0.053	0.1979
	[Comprehensive]	.	.	.	.	.	.
GCSE Maths Grade		0.662	0.012	<.0001	0.456	0.011	<.0001
GCSE Exam Year	2014	0.780	0.118	<.0001	0.365	0.086	<.0001
	2015	0.696	0.113	<.0001	0.340	0.084	<.0001
	2016	0.263	0.115	0.0219	0.151	0.082	0.0671
	2017	.	.	.	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	-0.115	0.018	<.0001	-0.098	0.016	<.0001
	2015	-0.092	0.017	<.0001	-0.056	0.015	0.0002
	2016	-0.026	0.017	0.1318	-0.015	0.015	0.3301
	2017	.	.	.	.	.	.

Appendix E: Progression to non-maths-related qualifications

Table E1: Overall progression (N) to non-maths-related subjects, before and after the reform

GCSE	Non-maths-related subjects (N)					
	Progression	History	English Literature	Sociology	Religious Studies	Geography
Pre-reform (2014 - 2016)	No	1467677	1474816	1494425	1526599	1500699
	Yes	105041	97902	78293	46119	72019
Post-reform (2017)	No	491232	500278	499674	517431	503779
	Yes	39250	30204	30808	13051	26703

Table E2: Overall progression (%) to non-maths-related subjects, before and after the reform (Number of students in Table E1 above)

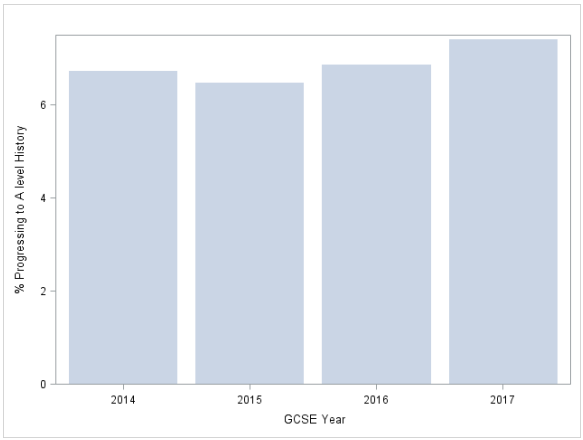
GCSE	Non-maths-related subjects (%)					
	Progression	History	English Literature	Sociology	Religious Studies	Geography
Pre-reform (2014 - 2016)	No	93.3	93.8	95.0	97.1	95.4
	Yes	6.7	6.2	5.0	2.9	4.6
Post-reform (2017)	No	92.6	94.3	94.2	97.5	95.0
	Yes	7.4	5.7	5.8	2.5	5.0

Table E3: Overall progression (N) to non-maths-related subjects

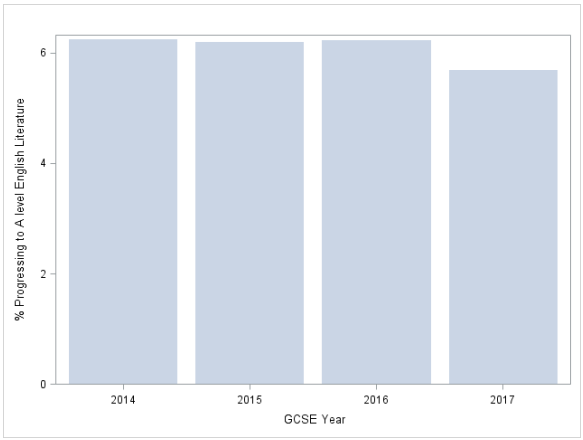
GCSE year	Non-maths-related subjects (N)					
	Progression	History	English Literature	Sociology	Religious Studies	Geography
2014	No	471969	474369	482549	490060	484221
	Yes	33993	31593	23413	15902	21741
2015	No	509694	511192	517804	528034	519004
	Yes	35290	33792	27180	16950	25980
2016	No	486014	489255	494072	508505	497474
	Yes	35758	32517	27700	13267	24298
2017	No	491232	500278	499674	517431	503779
	Yes	39250	30204	30808	13051	26703

Table E4: Overall progression (%) to non-maths-related subjects (Number of students in Table E3 above)

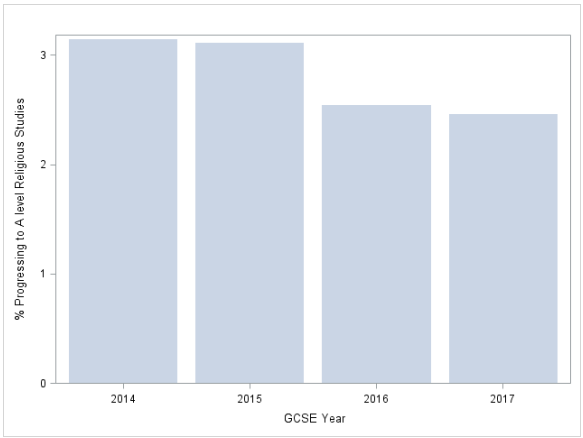
GCSE year	Non-maths-related subjects (%)					
	Progression	History	English Literature	Sociology	Religious Studies	Geography
2014	No	93.3	93.8	95.4	96.9	95.7
	Yes	6.7	6.2	4.6	3.1	4.3
2015	No	93.5	93.8	95.0	96.9	95.2
	Yes	6.5	6.2	5.0	3.1	4.8
2016	No	93.1	93.8	94.7	97.5	95.3
	Yes	6.9	6.2	5.3	2.5	4.7
2017	No	92.6	94.3	94.2	97.5	95.0
	Yes	7.4	5.7	5.8	2.5	5.0



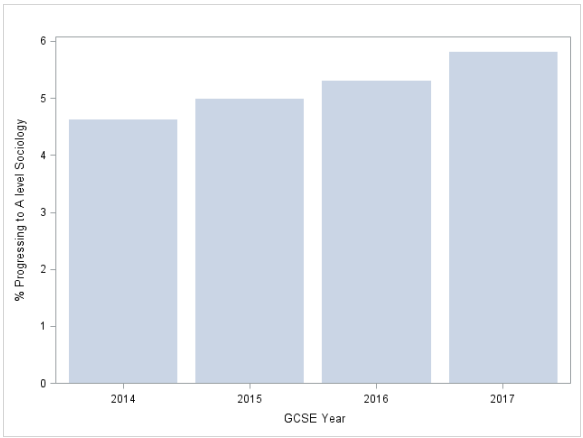
(a) History



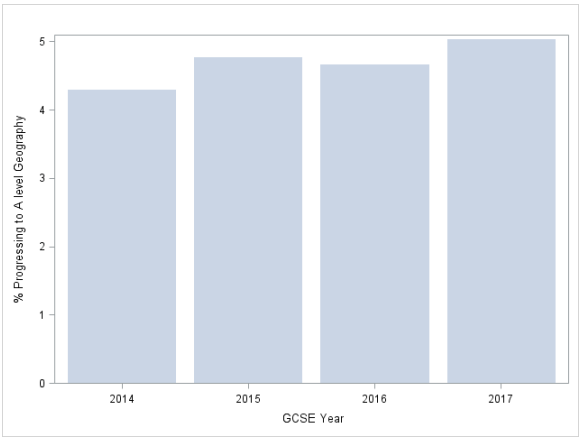
(b) English literature



(c) Religious studies

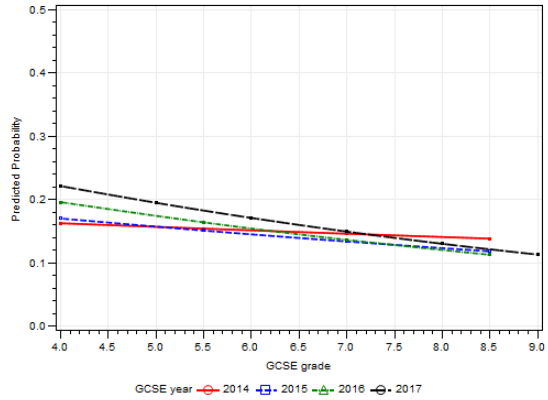


(d) Sociology

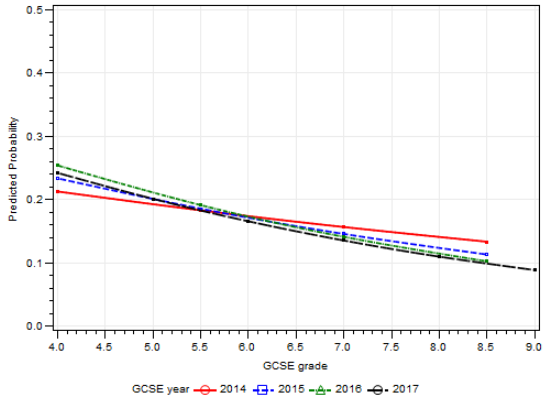


(e) Geography

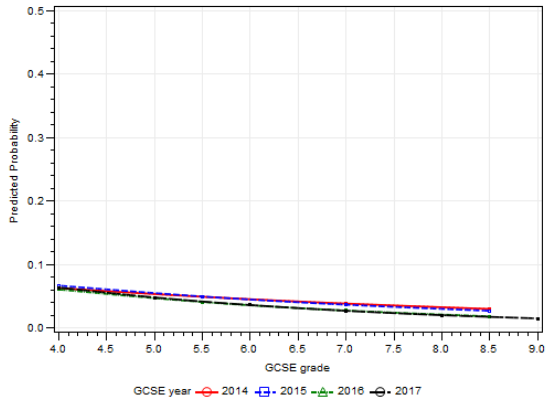
Figure E1: Overall progression to non-maths-related subjects by GCSE year (pre-reform: 2014 to 2016; post-reform: 2017)



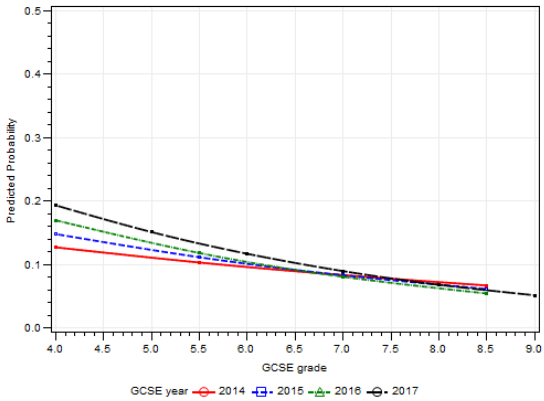
(a) History



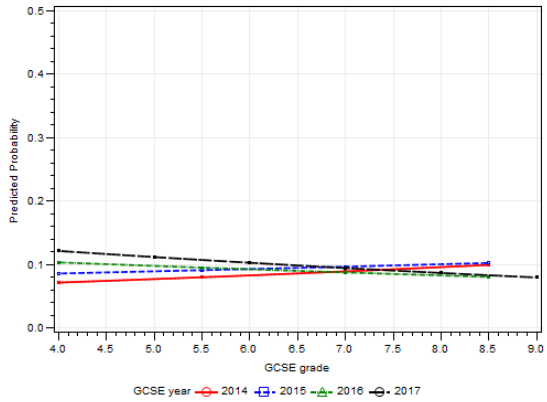
(b) English literature



(c) Religious studies



(d) Sociology



(e) Geography

Figure E2: Probability of progression to non-maths-related subjects, by GCSE year and GCSE maths grade (for the "typical" student)[11]

[11] Female; Prior attainment=high; deprivation=low; comprehensive school.

Table E5: Progression to A level history, regression analysis results (N=1761038)

Variable		Estimate	Standard Error	Pr > |t|
Intercept		-5.960	0.043	<.0001
Gender	Male	0.056	0.007	<.0001
	[Female]	.	.	.
Deprivation	Medium	-0.133	0.008	<.0001
	High	-0.324	0.010	<.0001
	[Low]	.	.	.
Prior attainment	Medium	3.811	0.038	<.0001
	High	5.344	0.039	<.0001
	[Low]	.	.	.
School Type	Independent	-1.729	0.720	0.0163
	Other	-1.196	0.130	<.0001
	Secondary Modern	-0.061	0.054	0.2533
	Selective	0.321	0.042	<.0001
	[Comprehensive]	.	.	.
GCSE Maths Grade		-0.160	0.004	<.0001
GCSE Exam Year	2014	-0.853	0.033	<.0001
	2015	-0.591	0.032	<.0001
	2016	-0.217	0.032	<.0001
	2017	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	0.118	0.005	<.0001
	2015	0.066	0.005	<.0001
	2016	0.016	0.005	0.0024
	2017	.	.	.

Table E6: Progression to A level English literature, regression analysis results (N=1761038)

Variable		Estimate	Standard Error	Pr > |t|
Intercept		-5.268	0.041	<.0001
Gender	Male	-1.098	0.009	<.0001
	[Female]	.	.	.
Deprivation	Medium	-0.083	0.008	<.0001
	High	-0.224	0.011	<.0001
	[Low]	.	.	.
Prior attainment	Medium	3.588	0.034	<.0001
	High	5.077	0.035	<.0001
	[Low]	.	.	.
School Type	Independent	-0.383	0.473	0.4182
	Other	-1.229	0.143	<.0001
	Secondary Modern	0.106	0.062	0.0898
	Selective	0.597	0.050	<.0001
	[Comprehensive]	.	.	.
GCSE Maths Grade		-0.238	0.004	<.0001
GCSE Exam Year	2014	-0.617	0.034	<.0001
	2015	-0.225	0.033	<.0001
	2016	0.083	0.033	0.0121
	2017	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	0.113	0.006	<.0001
	2015	0.044	0.006	<.0001
	2016	-0.005	0.006	0.3834
	2017	.	.	.

Table E7: Progression to A level religious studies, regression analysis results (N=1761038)

Variable		Estimate	Standard Error	Pr > |t|
Intercept		-6.006	0.054	<.0001
Gender	Male	-0.718	0.012	<.0001
	[Female]	.	.	.
Deprivation	Medium	-0.023	0.012	0.0651
	High	-0.042	0.015	0.0052
	[Low]	.	.	.
Prior attainment	Medium	3.510	0.041	<.0001
	High	4.509	0.043	<.0001
	[Low]	.	.	.
School Type	Independent	-0.292	0.734	0.6911
	Other	-1.172	0.222	<.0001
	Secondary Modern	0.060	0.115	0.6009
	Selective	0.802	0.093	<.0001
	[Comprehensive]	.	.	.
GCSE Maths Grade		-0.297	0.006	<.0001
GCSE Exam Year	2014	-0.519	0.047	<.0001
	2015	-0.299	0.045	<.0001
	2016	-0.143	0.047	0.0024
	2017	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	0.126	0.008	<.0001
	2015	0.087	0.008	<.0001
	2016	0.023	0.008	0.0074
	2017	.	.	.

Table E8: Progression to A level sociology, regression analysis results (N=1761038)

Variable		Estimate	Standard Error	Pr > |t|
Intercept		-4.400	0.033	<.0001
Gender	Male	-1.082	0.009	<.0001
	[Female]	.	.	.
Deprivation	Medium	-0.021	0.009	0.0225
	High	-0.012	0.011	0.2738
	[Low]	.	.	.
Prior attainment	Medium	3.562	0.024	<.0001
	High	4.155	0.026	<.0001
	[Low]	.	.	.
School Type	Independent	-0.729	0.471	0.1218
	Other	-1.812	0.160	<.0001
	Secondary Modern	0.004	0.071	0.9572
	Selective	-0.545	0.062	<.0001
	[Comprehensive]	.	.	.
GCSE Maths Grade		-0.296	0.004	<.0001
GCSE Exam Year	2014	-1.055	0.033	<.0001
	2015	-0.639	0.032	<.0001
	2016	-0.218	0.031	<.0001
	2017	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	0.139	0.006	<.0001
	2015	0.079	0.006	<.0001
	2016	0.015	0.006	0.0125
	2017	.	.	.

Table E9: Progression to A level geography, regression analysis results (N=1761038)

Variable		Estimate	Standard Error	Pr > |t|
Intercept		-6.904	0.062	<.0001
Gender	Male	0.239	0.008	<.0001
	[Female]	.	.	.
Deprivation	Medium	-0.265	0.009	<.0001
	High	-0.607	0.013	<.0001
	[Low]	.	.	.
Prior attainment	Medium	3.889	0.057	<.0001
	High	5.300	0.057	<.0001
	[Low]	.	.	.
School Type	Independent	-0.710	0.597	0.2344
	Other	-1.460	0.202	<.0001
	Secondary Modern	0.074	0.070	0.2913
	Selective	0.510	0.055	<.0001
	[Comprehensive]	.	.	.
GCSE Maths Grade		-0.094	0.005	<.0001
GCSE Exam Year	2014	-1.275	0.042	<.0001
	2015	-0.934	0.040	<.0001
	2016	-0.312	0.039	<.0001
	2017	.	.	.
GCSE Maths Grade * GCSE Exam Year	2014	0.173	0.007	<.0001
	2015	0.137	0.006	<.0001
	2016	0.033	0.006	<.0001
	2017	.	.	.