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The impact of taking Core Maths on students' higher education outcomes

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Abstract:

One of the main aims of Core Maths qualifications when they were introduced into the post-16 curriculum in 2014 was to help students develop their understanding of maths and its application to different subject areas, particularly in relation to further study (e.g., higher education). In this article, we explore whether Core Maths is fulfilling this aim. In particular, we answer the following questions:

- Are Core Maths students less likely than non-Core Maths students to drop out of higher education (HE) courses with a quantitative element?
- Is taking Core Maths associated with better degree performance in courses with a quantitative element?

We investigated these questions using logistic regression analysis. We found that Core Maths students had a slightly lower probability than non-Core Maths students of dropping out of HE in their first year, even after accounting for other factors likely to affect drop-out rates, such as prior attainment. The other main finding was that Core Maths students were slightly more likely to achieve a good degree classification.

These results suggest that taking Core Maths may benefit students taking a quantitative subject at HE, perhaps by giving them the skills they need to apply mathematical knowledge to their subject.

The impact of taking Core Maths on students' higher education outcomes

Tim Gill (Research Division)

Introduction

Core Maths (hereafter, "CM") qualifications were introduced into the curriculum in England in 2014 and were first assessed in 2016. These are qualifications which provide an alternative for students who want to continue with their mathematical education post-16, but do not want to take AS or A Level Maths. They are equivalent in size to half an A Level. In most schools or colleges, students wanting to study CM are required to achieve a pass (grade 4 or higher) at GCSE Maths.

Several different CM qualifications are available, with variation in the focus of the content. For example, some are designed to be taken alongside courses with a statistical element (e.g., A Level Psychology), while others are designed to be taken alongside courses with a more general quantitative element (e.g., A Level Economics).

A small number of previous studies have explored how well the main aims of the CM qualifications (to increase participation in post-16 maths and to help develop students' mathematical knowledge and its application to a range of different areas) have been met. These studies are summarised below.

- Aim 1: Increase participation in post-16 maths:
    - Uptake of CM qualifications has increased over time, from around 3000 entries in 2016 to nearly 13 000 in 2024 (AMSP, 2024).
    - However, the percentage of potential candidates (i.e., those passing GCSE Maths, but not taking A Level Maths) entering the qualification in 2021/22 was only 7 per cent (Royal Society, 2023).
    - There was a significant amount of variation between local authorities in the proportion of schools and colleges offering the subject, i.e., provision was "patchy" (Royal Society, 2023).
- Aim 2: Develop students' mathematical knowledge and its application:
    - In a survey, teachers and students reported that they were positive about CM, particularly its applications to real-world situations (Homer et al., 2020).

- o Teachers also believed that CM supported students with other subjects (e.g., A Levels) with mathematical content taken at the same time. However, early analysis found no empirical evidence of improved performance in these subjects (Homer et al., 2020).
- o More recent analysis found that in some subjects (with a quantitative element) taken concurrently, CM students performed slightly (but statistically significantly) better than non-CM students (Gill, 2024a).

One of the stated main purposes of CM qualifications was to help "develop students' understanding and application of maths in ways that are valuable for further study and employment across a range of areas" (DfE, 2013, p. 5). This suggests that CM qualifications may help students in their future study (in further or higher education (HE)) in subjects which have some mathematical content, such as sciences, psychology, business, and engineering.

There is some recognition from universities of the benefit of taking CM. Smith (2017) reported that (at the time of writing) 43 universities had shown individual support for CM qualifications, including 23 Russell Group institutions. The Advanced Mathematics Support Programme (AMSP, 2024) lists 10 universities which make lower admissions offers in some subjects to students with a CM qualification. This demonstrates that some universities believe that CM can benefit students in their HE studies.

The main purpose of the research presented here was to investigate whether there is any evidence that taking a CM qualification is helpful to students in terms of HE outcomes (specifically, drop-out rates and degree performance).

The research questions were:

- Are Core Maths students less likely than non-Core Maths students to drop out of HE courses with a quantitative element?
- Is taking Core Maths associated with better degree performance in courses with a quantitative element?

In answering these research questions, we restricted our analysis to HE subjects with some quantitative element, as these are the subjects where taking CM is most likely to be beneficial.

Data and methods

The main source of data for this project was a dataset linking students' records in the National Pupil Database (NPD) and in the Higher Education Statistics Agency (HESA) database. The NPD is administered by the Department for Education (DfE) and includes examination results for all students in all qualifications and subjects in schools and colleges in England, as well as student and school background characteristics such as gender, ethnicity, level of income-related deprivation and school type. The HESA data has information on the students who attend universities in the UK. It includes details of the institution attended, the course subject and level, the degree classification obtained (where applicable) and some additional background characteristics, such as socioeconomic status and level of parental education.

All data was accessed and used in line with the requirements of the organisations that administer these databases. This work was carried out in the Secure Research Service, part of the Office for National Statistics (ONS).

We used the Key Stage 5 (KS5) extract of the NPD for 2017/18 linked to HESA data in 2018/19, 2019/20 and 2020/21. This enabled us to investigate the relationship between taking CM and the probability of dropping out of HE courses with a quantitative element and the probability of achieving a "good" degree (first class or upper second-class) in courses with a quantitative element.

To select the courses with a quantitative element we used the HESA subject classifications, known as the Common Aggregation Hierarchy (CAH).[1] Using the highest level of aggregation, we identified courses from the following classifications as likely to have a quantitative element:

- Biological and sport sciences
- Psychology
- Physical sciences
- Engineering and technology
- Geography, earth and environmental sciences
- Social sciences
- Business and management

Note that subjects in the mathematical sciences group were not included because students taking these subjects would be expected to have A Level Maths and, therefore, are unlikely to have studied Core Maths.

Some students took combined courses where they studied more than one subject. For these students, if more than 50 per cent of the course was in a subject classified as having a quantitative element, then the student was counted as taking a subject with a quantitative element. Otherwise, the student was excluded.

We also excluded students who took AS or A Level Maths. This meant we were able to directly compare students who took CM with those not taking any KS5 maths qualification.

For the analysis of drop-out rates we considered two possible degree start dates (2018/19 and 2019/20). Students who were present in the HESA data (and taking a subject with a quantitative element) in year 1 of their degree but were not present (or were no longer taking a subject with a quantitative element) in year 2 were counted as having dropped out of HE in their first year. This is not a perfect measure, as some of these students may have transferred to a university in a different country or taken a year out (i.e., not dropped out), but we assumed that this was a very small number and would not, therefore, affect the results. We combined data from the two separate start years, so that students who started HE in 2018/19 but were not in the data for 2019/20, and students who started in 2019/20 (i.e., those who deferred a year) but were not in the data for 2020/21, were counted as dropping out.

1 See https://www.hesa.ac.uk/support/documentation/hecos/cah

For the analysis of degree class achieved, we focused on students who were at the end of KS5 in 2017/18 and who completed a degree in 2020/21 (according to the HESA data). This means that the analysis was limited to students who started HE immediately after finishing school and completed their degree in three years. This will therefore exclude any students who took four-year courses, or those who took a year out during their degree.

For both research questions, the initial analysis was descriptive, showing patterns of drop-out and achievement in HE. Then, we carried out logistic regression analyses to fully account for the students' backgrounds when investigating drop-out and attainment for CM and non-CM students.

Regression analysis

For both research questions, logistic regression models were fitted.

The first set of regression models predicted the probability of a student taking a subject with a quantitative element dropping out of HE in their first year.[2] For these models, we used a cross-classified multilevel model, which accounted for two separate hierarchies in the data: students clustered in schools and in HE institutions. For a more detailed description of multilevel logistic regressions see Goldstein (2011). The general form of the model was:

$$\log\left(\frac{p_{ijk}}{1-p_{ijk}}\right) = \beta_0 + \beta_1 x_{1ijk} + \beta_2 x_{2ijk} + \ldots + \beta_l x_{lijk} + u_j + u_k$$

where p_{ijk} is the probability of student i from school j attending HE institution k dropping out of HE, x_{1ijk} to x_{lijk} are the independent variables, β_0 to β_l are the regression coefficients, u_j is a random variable at school level and u_k is a random variable at HE institution level.

The second set of models predicted the probability of achieving a first-class degree in a quantitative subject (and separately the probability of achieving at least an upper second-class degree). A cross-classified multilevel model was employed here too, with students nested in schools and in HE institutions. The general form of the model was:

$$\log\left(\frac{p_{ijk}}{1-p_{ijk}}\right) = \beta_0 + \beta_1 x_{1ijk} + \beta_2 x_{2ijk} + \ldots + \beta_l x_{lijk} + u_j + u_k$$

where p_{ijk} is the probability of student i from school j and achieving a first (or, separately, at least an upper second) in HE institution k and all other terms are as in the model predicting drop-out.

Analysis was carried out in the R programming language, with the regression models fitted using the *glmer* function from the *lme4* package (Bates et al., 2015).

2 An additional analysis was undertaken predicting the probability of a student dropping out in either year 1 or year 2. The results of this analysis are not presented in this article but are shown in Gill (2024b).

In each regression model, we included contextual variables which were likely to affect the outcome variable. The majority of these variables were taken from the NPD: gender, KS5 attainment, deprivation, ethnic group, first language, special educational needs (SEN) status, total size of qualifications taken at KS5, school type, school gender composition, and school mean KS5 attainment. Other contextual variables were taken from the HESA data: students' socioeconomic classification, their parents' level of education, and the degree subject group. These variables are described in more detail below.

None of these characteristics were directly related to the research questions being addressed, but it was important that they were included in the models because it allowed us to be more confident that any significant effect of taking CM was genuine and not down to differences in the other factors. They were all characteristics which previous research (e.g., Chowdry et al., 2013; Gill, 2017; Vidal Rodeiro, 2019; Gill, 2024c) found to be significant factors in determining the likelihood of drop-out or of degree class achieved.

For the measure of KS5 attainment, we used the students' average KS5 points score. This variable was already in the NPD data and was generated by assigning a points score to each achieved grade[3] and averaging this across all KS5 qualifications (at least equivalent in size to an A Level) taken by a student. The measure, therefore, excluded the grade achieved in CM (for those students who took it), as this is equivalent in size to half an A Level.

For the measure of student deprivation, we used the NPD variable Income Deprivation Affecting Children Index (IDACI), which indicates the proportion of children in a very small geographical area (known as Lower layer Super Output Area or LSOA) living in low-income families.[4] It varies between 0 and 1 and indicates how income-deprived the area is that they live in. As such, it cannot tell us how income-deprived the individual students themselves are but it should be a good proxy for this measure.

Students were grouped in the NPD by their ethnic background: Asian, Black, Chinese, mixed, white, other, and unclassified. Chinese students were in a category of their own in the NPD data, likely because they tend to perform better academically than other Asian students (see, for example, DfE, 2015). Students were also grouped by their first language (English or other).

For students' SEN status, we used the categories in the NPD. These were "No SEN", "SEN, no statement", and "SEN, with statement", with the last of these indicating children requiring the most support.[5]

For the four student characteristics described so far (IDACI score, ethnicity, language, and SEN), around 50 per cent of students had missing data. This

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3 For example, a grade A* at A Level was worth 60 points, a grade A worth 50 points, down to a grade E (10 points) and a grade U (0 points). More details on how grades are converted to scores can be found at https://www.gov.uk/government/publications/16-to-19-qualifications-discount-codes-and-point-scores

4 For further information on IDACI calculation, including definitions of children, families, and income deprivation, see Smith et al. (2015).

5 A statement of special educational needs is a legal document which outlines the educational needs of the child and how they will be met by the local education authority.

was because these variables are collected as part of the school census, which independent schools and colleges are not required to complete. As such, this data was mostly missing for students in these school types. Students with missing data for any of these variables were excluded from most of the analysis involving the variables, such as the regression models. However, as including the census variables meant losing a large amount of candidates, we repeated the regression analysis without these variables. This allowed us to include many more candidates, which can help to understand how robust any findings from the first model were.

The student total qualification size variable indicated the total size of the KS5 qualifications taken by each student, measured in A Level equivalents. For example, a student taking three A Levels would have a value of 3. Other qualifications were already assigned an equivalent size in the NPD (e.g., BTECs were equivalent in size to either one, two or three A Levels).

For the analysis by school type, schools were grouped into six categories: comprehensive (including academies and secondary moderns), sixth form colleges, further education (FE) / tertiary colleges, independent schools, selective schools, and other schools. This information was taken from the school type and the admission policy variables in the NPD.

We also categorised schools and colleges by their gender composition (i.e., boys', girls', or mixed). To do this, we calculated the percentage of girls in each school. If this was greater than 95 per cent then the school was categorised as a girls' school, if it was less than 5 per cent it was categorised as a boys' school. Otherwise, it was categorised as a mixed school.

To generate the school KS5 attainment measure (centre KS5 point score), we calculated the average KS5 points score among all students in the school, based on achieved grades.

In the HESA data, students were classified by their socioeconomic status (SES), based on their parents' occupation if they were under 21 or their own occupation if 21 or over. The categories used are standard categories used in the UK census, which run from 1 ("Higher managerial & professional occupations") to 8 ("Never worked & long-term unemployed"), with 9 indicating "not classified" (which includes students).[6]

Students were also classified according to whether at least one of their parents had an HE qualification (e.g., degree, diploma, or certificate of HE) or not.

Finally, the degree subject group was included in some models. This was based on the Common Aggregation Hierarchy (CAH) classification, mentioned earlier in this article.

For each set of regression models, variables which were not statistically significantly different from zero[7] were excluded. A backwards stepwise procedure was used to decide in which order to exclude non-significant variables, starting

6 For a full list of the different categories, see https://www.hesa.ac.uk/collection/c16051/a/sec

7 Statistical significance was determined by the Wald Z-test at the 5 per cent level.

with the variable with the highest *p* value and continuing to remove variables in this way until all were statistically significant. Removing non-significant variables in this way is useful when there are a large number of potential predictor variables, as it makes the final model easier to interpret.

To ensure confidentiality of the data, statistical disclosure controls have been applied to the results (tables and graphs). For example, following HESA disclosure requirements (https://www.hesa.ac.uk/about/regulation/data-protection/rounding-and-suppression-anonymise-statistics) all counts have been rounded up or down to the nearest 5 and counts below 10 and percentages based on counts below 10 have either been suppressed or merged with other counts/percentages.

Results

Are Core Maths students less likely than non-Core Maths students to drop out of HE courses with a quantitative element?

As noted earlier, the definition of drop-out used in the analysis was students who either left HE completely, or those who changed course from a subject with a quantitative element to a non-quantitative subject. Table 1 shows the number of students dropping out in year 1 (Y1) according to this definition (whether or not they took CM in KS5).

Table 1: Drop-out status (Y1) of students starting a quantitative subject

Drop-out status	N students	% students
Did not drop out	65 825	87
Dropped out of HE	4 375	6
Changed to a non-quantitative subject	5 280	7
All who dropped out	9 655	13
All students	**75 480**	**100**

Around 6 per cent of students dropped out completely in year 1 and about 7 per cent changed to a non-quantitative subject. For simplicity, in all further analysis we only look at the combined total drop-outs.

Table 2 presents the numbers and percentages dropping out, by whether CM was taken. This shows that there was very little difference in percentage dropping out for CM (12 per cent) and non-CM students (13 per cent).

Table 2: Drop-out status (Y1) of students starting a quantitative subject, by Core Maths uptake

Taken Core Maths?	N taking quantitative subject	N dropping out	% dropping out
No	73 830	9460	13
Yes	1650	195	12

To look in more detail at drop-out rates, the results of the regression predicting drop-out from a subject with a quantitative element are presented in Table 3. This shows the parameter estimates (with standard errors in brackets). Statistical significance (at the 5 per cent level) is indicated by an asterisk.

For this analysis we fitted three different regression models. In model 1, the statistically significant student and school level variables were included. Model 1a added in significant interaction effects between taking CM and the other predictor variables. Model 2 excluded the census variables, meaning that a much higher number of students were included. We did not try extending model 2 by including interaction effects as the main reason for including this model was to check the robustness of the main model (model 1). Overall, model 1 and model 2 showed similar results for the main effects of interest, indicating that the results in model 1 were not strongly affected by the reduced sample size.

In models 1 and 2, the negative parameter estimates for Core Maths indicated that taking Core Maths was associated with a lower probability of dropping out. The effect is illustrated in Figure 1, which shows the probability for "typical"[8] students with different KS5 points scores (using the results of model 1). However, in model 1 this effect was not statistically significant. This contrasts with model 2, where the parameter estimate was slightly higher and was statistically significant. This difference in statistical significance was partly due to having a much larger number of observations in model 2, leading to a smaller standard error.

Table 3: Regression parameters for models predicting the probability of dropping out (in Y1) of a subject with a significant quantitative element (Model 1 = student level variables; Model 1a = interactions; Model 2 = excluding census variables)

Effect		**Model 1 (n=36 315)**	**Model 1a (n=36 315)**	**Model 2 (n=74 680)**
Intercept		-1.423 (0.058)*	-1.439 (0.058)*	-1.490 (0.058)*
Taken Core Maths	No			
	Yes	-0.155 (0.102)	0.293 (0.174)	-0.198 (0.082)*
Gender	Female			
	Male	-0.149 (0.037)*	-0.148 (0.037)*	-0.172 (0.025)*
KS5 points score		-0.017 (0.002)*	-0.017 (0.002)*	-0.014 (0.001)*
IDACI score		0.604 (0.134)*	0.609 (0.135)*	
Candidate total qualification size		-0.082 (0.034)*	-0.083 (0.034)*	-0.038 (0.017)*

8 For the purpose of exemplification, we define "typical" students as female, attending a comprehensive school, taking a subject in the biological and sport sciences subject group, with parents educated to degree level, and with values of continuous variables equal to the mean. The means for the continuous variables are shown in Table A1 of Appendix A.

Effect		Model 1 (n=36 315)	Model 1a (n=36 315)	Model 2 (n=74 680)
Subject group	Biological & sport sciences			
	Business & management	-0.837 (0.050)*	-0.808 (0.050)*	-0.788 (0.033)*
	Engineering & technology	0.135 (0.086)	0.214 (0.088)*	-0.028 (0.051)
	Geography, earth & environmental sciences	-1.705 (0.169)*	-1.836 (0.183)*	-1.536 (0.121)*
	Physical sciences	-0.704 (0.083)*	-0.701 (0.085)*	-0.651 (0.057)*
	Psychology	-1.341 (0.066)*	-1.316 (0.066)*	-1.166 (0.045)*
	Social sciences	-0.722 (0.050)*	-0.708 (0.050)*	-0.673 (0.034)*
	Combined	-0.398 (0.090)*	-0.404 (0.092)*	-0.246 (0.059)*
Parent educated to degree level	Yes			
	No			0.137 (0.025)*
	Don't know / refused			0.038 (0.037)
School type	Comprehensive / academy			
	6th form college			0.128 (0.042)*
	FE / tertiary college			0.222 (0.038)*
	Independent			-0.048 (0.055)
	Other			0.016 (0.052)
	Selective			-0.021 (0.065)
Taken Core Maths* subject group	Biological & sport sciences			
	Business & management		-1.042 (0.313)*	
	Engineering & technology		-1.213 (0.348)*	
	Geography, earth & environmental sciences		1.646 (0.516)*	
	Physical sciences		-0.148 (0.392)	
	Psychology		-0.977 (0.493)*	
	Social sciences		-0.362 (0.315)	
	Combined		0.162 (0.446)	

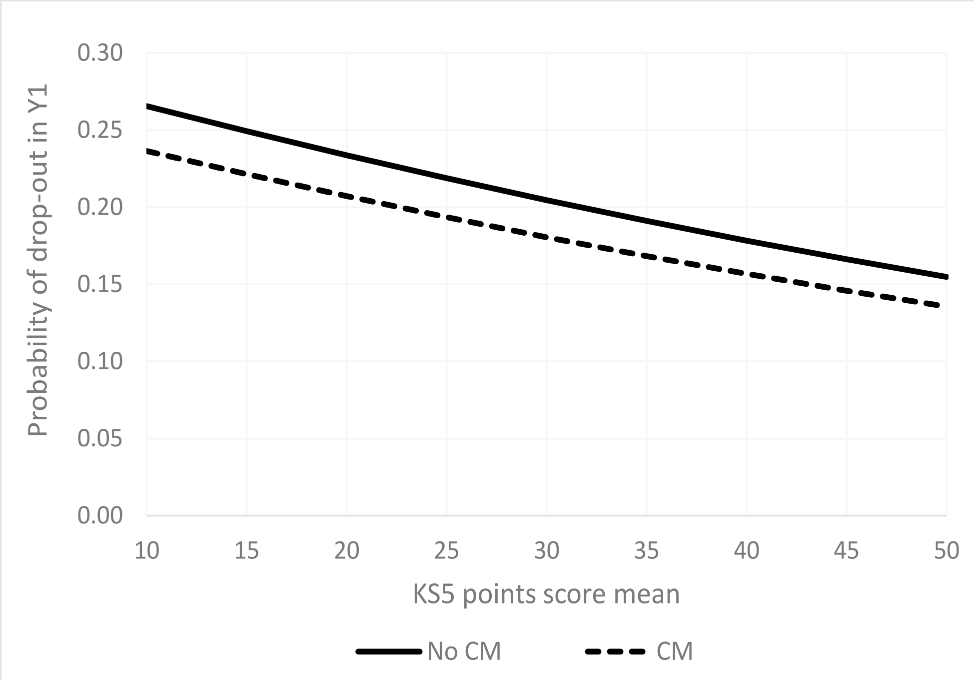

Figure 1: Predicted probabilities of drop-out in year 1, by CM and KS5 mean points score (model 1)

Figure 1 illustrates that the difference in probability according to the model between CM and non-CM students was not large. For example, for students with a mean KS5 points score equal to the mean among all students (33.2, equivalent to one B grade and two C grades at A Level), the probability of dropping out was 0.17 for CM students and 0.20 for non-CM students.

In the model with interactions (model 1a), interpretation of parameter estimates changes. The "main" effect of CM on drop-out rate refers only to the base subject category (biological and sport sciences); from this, we see higher drop-out rates for CM students, but the effect was not statistically significant. The interaction terms (in the bottom rows of the table) show how the effect in that subject differs from the base subject. Several of these were statistically significant, indicating that there was subject-to-subject variation in the effect of CM on drop-out rates. However, from these parameters, we cannot say whether the difference between CM and non-CM students was statistically significant in each subject. Overall, then, the model showed *lower* drop-out rates for CM students in business, engineering, and psychology, but *higher* drop-out rates for CM students in biological sciences, geography, and physical sciences. In combined studies and social sciences, the effect was close to zero. As the size and direction of effects differed between subjects, we illustrate the probabilities of dropping out for CM and non-CM students, by the different subject groups, in Figure 2.

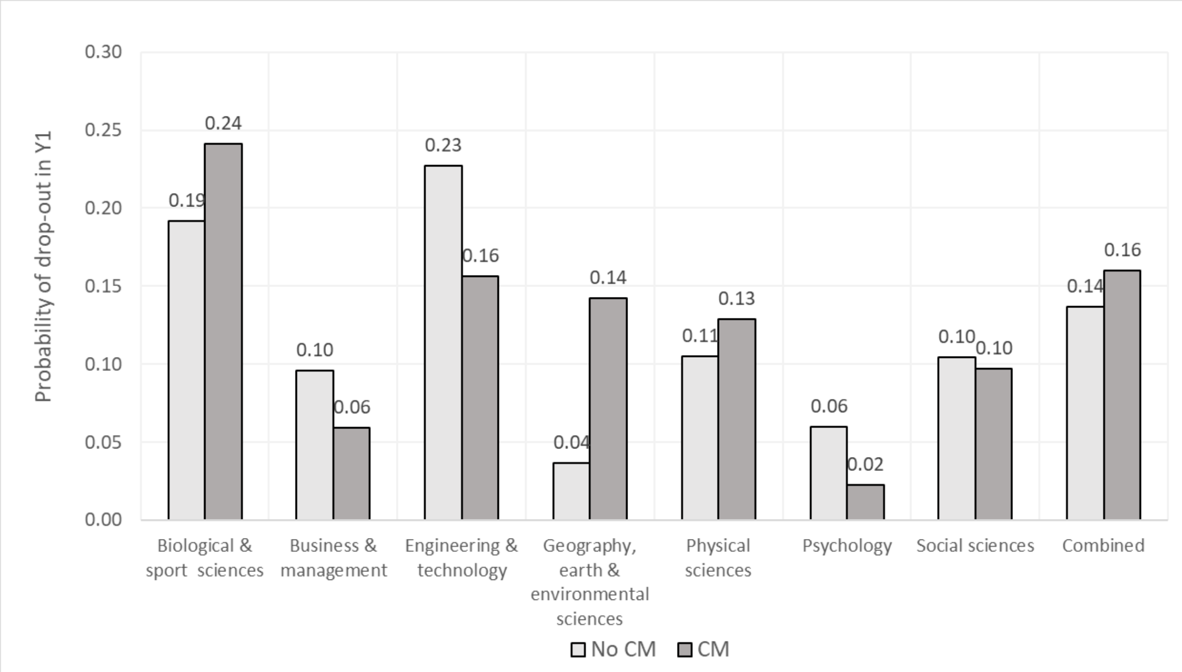

Figure 2: Predicted probabilities of drop-out in year 1, by CM and subject group (model 1a)

Is taking Core Maths associated with better degree performance in courses with a quantitative element?

Achieving a first-class degree

Table 4 shows the overall numbers and percentages of students achieving a first-class degree, by whether they took CM. This shows that CM students were slightly more likely to achieve a first (33 per cent) than non-CM students (29 per cent).

Table 4: First-class degree status, by Core Maths uptake

Taken Core Maths?	N achieving degree in quantitative subject	N achieving a first	% achieving a first
No	31 480	9135	29
Yes	670	220	33

The results of the regression analysis looking at the probability of achieving a first-class degree are presented in Table 5. As before, this shows the parameter estimates (with standard errors in brackets). Statistical significance (at the 5 per cent level) is indicated by an asterisk.

We fitted two different models. In model 1, the statistically significant student and school level variables were included, and model 2 excluded the census variables. We fitted models with interaction effects between CM and the other variables in model 1, but none of these were statistically significant so are not shown here.

Table 5: Regression parameters for models predicting the probability of achieving a first in a subject with a significant quantitative element (Model 1 = student and school level variables; Model 2 = excluding census variables)

Effect		**Model 1 (n=17 230)**	**Model 2 (n=31 795)**
Intercept		-0.216 (0.087)*	-0.291 (0.072)*
Taken Core Maths	No		
	Yes	0.216 (0.111)	0.319 (0.091)*
Gender	Female		
	Male	-0.507 (0.041)*	-0.476 (0.030)*
KS5 points score		0.065 (0.003)*	0.053 (0.002)*
IDACI score		-1.290 (0.175)*	
Candidate total qualification size		0.264 (0.039)*	0.226 (0.024)*
Ethnic group	White		
	Other	-0.321 (0.150)*	
	Asian	-0.182 (0.069)*	
	Black	-0.735 (0.090)*	
	Chinese	-0.052 (0.283)	
	Mixed	-0.299 (0.090)*	
	Unclassified	-0.167 (0.172)	
Language	English		
	Other	-0.303 (0.064)*	
	Unclassified	-0.857 (0.358)*	
Socioeconomic status (SES)	1		
	2	-0.028 (0.051)	-0.066 (0.038)
	3	-0.170 (0.066)*	-0.163 (0.050)*
	4	-0.255 (0.076)*	-0.217 (0.057)*
	5	-0.045 (0.085)	-0.025 (0.066)
	6	-0.219 (0.072)*	-0.309 (0.053)*
	7	-0.234 (0.082)*	-0.328 (0.061)*
	8	-0.108 (0.267)	-0.195 (0.199)
	9	-0.181 (0.067)*	-0.233 (0.048)*
Parents educated to degree level	Yes		
	No		-0.078 (0.031)*
	Don't know / refused		-0.246 (0.047)*

Effect		Model 1 (n=17 230)	Model 2 (n=31 795)
Subject group	Biological & sport sciences		
	Business & management	0.216 (0.060)*	0.183 (0.043)*
	Engineering & technology	0.258 (0.181)	0.316 (0.106)*
	Geography, earth & environmental sciences	-0.207 (0.081)*	-0.090 (0.062)
	Physical sciences	0.557 (0.138)*	0.371 (0.095)*
	Psychology	-0.467 (0.063)*	-0.379 (0.048)*
	Social sciences	-0.338 (0.058)*	-0.271 (0.043)*
	Combined	-0.348 (0.118)*	-0.231 (0.089)*
School type	Comprehensive / academy		
	6th form college	0.088 (0.179)	-0.278 (0.055)*
	FE / tertiary college	0.761 (0.582)	-0.673 (0.054)*
	Independent	0.036 (1.331)	-0.046 (0.067)
	Other	-0.184 (0.062)*	-0.225 (0.061)*
	Selective	0.225 (0.070)*	0.205 (0.070)*
Centre KS5 points score		-0.029 (0.005)*	-0.012 (0.004)*

The results show that there was a positive effect of taking CM on the probability of achieving a first in a quantitative subject. However, this difference was not statistically significant in the main model (model 1). The size of the effect is illustrated in Figure 3, which shows the probabilities for "typical"[9] CM and non-CM students at different levels of KS5 mean points score. For example, at the mean value of KS5 points score mean (35.1) CM students had a probability of a first of 0.50, compared with 0.45 for non-CM students.

Comparing model 1 with model 2, the effect of excluding the census variables and increasing sample size on the parameter estimates was small. However, there were some differences in the statistical significance of these estimates, with the parameter estimate for taking CM not significant in model 1 and significant in model 2. This was due in part to having a much larger number of observations in model 2, leading to a smaller standard error.

9 We define "typical" students in this case to be female, attending a comprehensive school, taking a course in the biological sciences subject group, with parents educated to degree level, in socioeconomic classification group 1, and with values of continuous variables equal to the mean. The means for the continuous variables are shown in Table A2 of Appendix A.

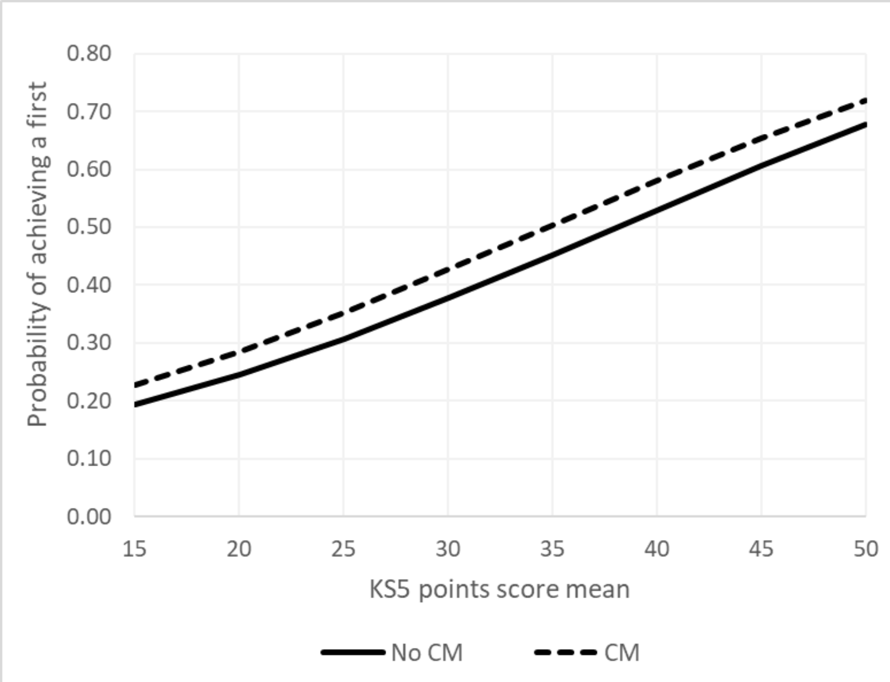

Figure 3: Predicted probabilities of achieving a first, by CM uptake and KS5 mean points score (model 1)

Achieving at least an upper second-class degree

Table 6 shows the overall numbers and percentages of students achieving an upper second-class degree or higher, by CM uptake. This shows that CM students were slightly more likely to achieve at least an upper second (87 per cent) than non-CM students (84 per cent).

Table 6: Upper second-class degree (or higher) status, by Core Maths uptake

Taken Core Maths?	N achieving degree in quantitative subject	N achieving at least an upper second	% achieving at least an upper second
No	31 480	26 490	84
Yes	670	580	87

The results of the regression models looking at the probability of achieving at least an upper second-class degree are shown in Table 7. In model 1, the significant student and school level variables were included, and model 2 excluded the census variables. We again fitted models with interaction effects between taking CM and the other variables in model 1, but none of these were statistically significant, so we do not show the results.

Table 7: Regression parameters for models predicting the probability of achieving at least an upper second in a subject with a significant quantitative element (Model 1 = student and school level variables; Model 2 = excluding census variables, due to missing data)

Effect		Model 1 (n=17 230)	Model 2 (n=31 795)
Intercept		2.383 (0.100)*	2.220 (0.077)*
Taken Core Maths	No		
	Yes	0.426 (0.160)*	0.350 (0.122)*
Gender	Female		
	Male	-0.560 (0.053)*	-0.522 (0.036)*
KS5 points score		0.056 (0.003)*	0.040 (0.002)*
IDACI score		-1.547 (0.206)*	
Candidate total qualification size		0.292 (0.057)*	0.226 (0.033)*
Ethnic group	White		
	Other	-0.293 (0.167)	
	Asian	-0.197 (0.085)*	
	Black	-0.748 (0.089)*	
	Chinese	0.910 (0.539)	
	Mixed	-0.172 (0.111)	
	Unclassified	0.051 (0.227)	
Language	English		
	Other	-0.164 (0.074)*	
	Unclassified	0.084 (0.367)	
Socioeconomic status (SES)	1		
	2	0.006 (0.077)	-0.120 (0.053)*
	3	-0.266 (0.089)*	-0.350 (0.062)*
	4	-0.177 (0.101)	-0.216 (0.071)*
	5	-0.123 (0.119)	-0.192 (0.084)*
	6	-0.200 (0.093)*	-0.435 (0.064)*
	7	-0.299 (0.103)*	-0.424 (0.072)*
	8	-0.536 (0.287)	-0.373 (0.212)
	9	-0.208 (0.091)*	-0.374 (0.061)*
Parents educated to degree level	Yes		
	No		-0.002 (0.038)
	Don't know / refused		-0.162 (0.055)*

Effect		Model 1 (n=17 230)	Model 2 (n=31 795)
Subject group	Biological & sport sciences		
	Business & management	0.552 (0.078)*	0.527 (0.051)*
	Engineering & technology	0.099 (0.220)	0.329 (0.122)*
	Geography, earth & environmental sciences	0.287 (0.121)*	0.442 (0.090)*
	Physical sciences	0.459 (0.207)*	0.392 (0.122)*
	Psychology	0.200 (0.085)*	0.326 (0.060)*
	Social sciences	0.062 (0.074)	0.100 (0.051)*
	Other	0.089 (0.152)	0.189 (0.103)
School type	Comprehensive / academy		
	6th form college	0.131 (0.245)	-0.379 (0.064)*
	FE / tertiary college	0.310 (0.694)	-0.733 (0.059)*
	Independent	-3.291 (1.340)*	0.185 (0.083)*
	Other	-0.126 (0.075)	-0.187 (0.074)*
	Selective	0.462 (0.112)*	0.463 (0.106)*
Centre KS5 points score		-0.018 (0.007)*	

These results show a significant and positive effect of taking CM on the probability of achieving at least an upper second. This is illustrated in Figure 4, which shows the probabilities for "typical"[10] students with different levels of KS5 mean points score (using the results of model 1).

The size of the effect was not large: at the mean value of KS5 points score mean (35.1) CM students had a probability of a first of 0.94, compared with 0.92 for non-CM students. For higher values of the KS5 points score mean the probabilities for CM and non-CM students were even closer.

There were mostly only small differences between the parameter estimates in model 1 (including census variables) and model 2 (excluding census variables). In particular, the estimate for taking CM fell from 0.426 to 0.350. As there was no change to the statistical significance of this estimate, the finding that taking CM was beneficial was unchanged.

10 We define "typical" students in this case to be female, white, with English as their first language, attending a comprehensive school, taking a course in the biological and sport sciences subject group, with parents educated to degree level, in socioeconomic classification group 1, and with values of continuous variables equal to the mean. The means for the continuous variables are shown in Table A3 of Appendix A.

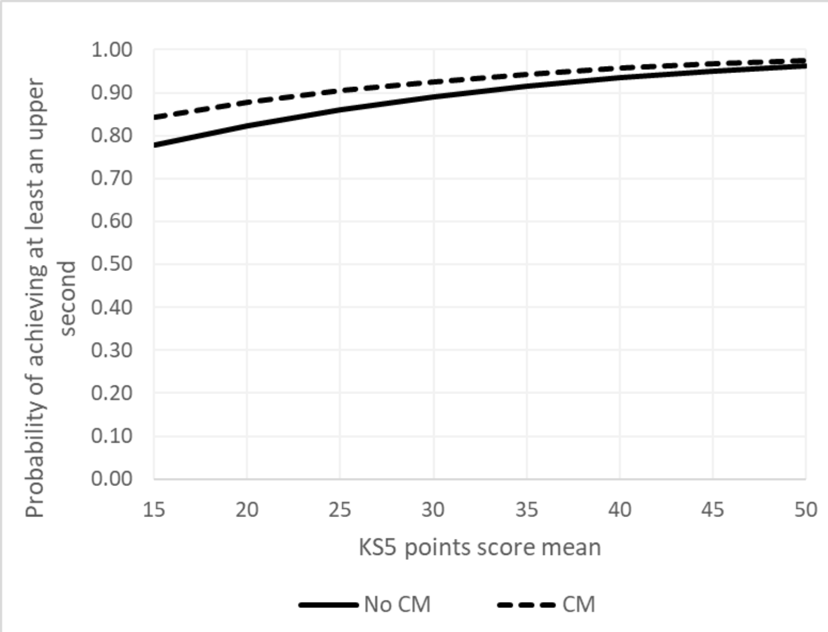

Figure 4: Predicted probabilities of achieving at least an upper second, by CM uptake and KS5 mean points score (model 1)

Conclusions

The main purpose of the analysis presented in this article was to investigate whether CM was beneficial, in terms of HE outcomes, for those students taking it.

The results presented here were part of a more comprehensive analysis into the potential benefits of taking CM (see Gill, 2024b). One of the main findings from that analysis (but not shown in this article) was that CM students were significantly more likely to progress to HE in a subject with a quantitative element (probability of 0.49 for a typical CM student compared to 0.39 for a typical non-CM student). This was not a surprising finding as many students will have taken the qualification in the expectation of studying further in a quantitative subject.

The results presented in this article focused on outcomes at HE, specifically whether students taking Core Maths were less likely to drop out of HE, and more likely to achieve a good HE degree in subjects with a quantitative element, than those not taking the qualification.

In terms of drop-out rates, descriptive statistics indicated that CM students were slightly less likely to drop out than non-CM students. Statistical models showed somewhat variable effects. In the models with a smaller sample (but including census variables), the effect was subject-dependent, with negative effects on drop-out rate seen in business and management, engineering and technology, and psychology courses. Somewhat surprisingly, there were *positive* effects (i.e., a greater drop-out rate for CM students) in biological and sport sciences, and geography, earth and environmental sciences. Other subject groups showed only very small effects. When the whole sample was included (but census variables were excluded) there was an overall negative effect of taking CM on dropping out: i.e., students that took CM were significantly less likely to drop out. Overall, then, it seems that taking CM can be associated with reduced risk of dropping out of HE, but not across all subjects.

In terms of the probability of students gaining an upper second-class degree, CM had a significant, positive impact regardless of the model and sample used. The effect was small (0.94 for CM students, 0.92 for non-CM students), but this might be because such a high proportion of students achieved an upper second-class degree anyway. In terms of the probability of students gaining a first-class degree, the models again indicated a positive effect of taking CM, but this was not statistically significant in the main model. However, in the model with the larger sample this was significant (probability of 0.51 for CM students, 0.43 for non-CM students).

Perhaps surprisingly, there was no evidence of differences in the effect of taking CM on degree outcomes for the different subject groups (i.e., no significant interaction effect between CM and subject group). This may be related to using high-level subject grouping in the regression analysis. Using finer subject classifications instead might have identified significant differences between subjects in the effect of taking CM on degree outcomes, perhaps due to their differences in mathematical content. Alternatively, the issue may be that our analysis is limited by the fairly small numbers of CM students taking some individual subjects within each subject group.

Taken together, these findings suggest that taking CM may be beneficial to students taking a quantitative subject at HE. When we included the full sample of students, those taking CM were significantly less likely to drop out and significantly more likely to achieve a good degree. When a more limited sample was included, permitting additional contextual variables to be included, effects were similar but were not always statistically significant, or appeared to vary between subjects. Nevertheless, the overall results are encouraging and suggest that CM can help in the way it is intended to. These findings should encourage more universities to follow the policy of making reduced offers to students with CM or to welcome its addition to students' programmes of study.

Finally, there was one notable limitation with this research: that association does not mean causation. There may be other reasons why CM students were less likely to drop out and more likely to achieve a good degree that were not directly related to taking CM. For instance, it may be that students taking CM were more motivated to do well academically than non-CM students and it was this that led to better outcomes at HE, rather than taking CM per se. It would be interesting to undertake further research into this, by speaking with students in HE (across a range of different subject areas) who took CM, to find out their motivation for taking CM and whether they believed it had helped them with their HE studies.

Acknowledgements

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Appendix A

Table A1: Mean values of continuous variables used in regression models (probability of drop-out year 1)

Variable	N students	Mean
KS5 points score	75 095	33.23
IDACI score	36 440	0.17
Candidate total qualification size	75 480	3.19
Centre KS5 points score	75 125	32.03

Table A2: Mean values of continuous variables used in regression models (probability of first)

Variable	N students	Mean
KS5 points score	31 980	35.09
Candidate total qualification size	32 150	3.30
Centre KS5 points score	31 990	32.26

Table A3: Mean values of continuous variables used in regression models (probability of at least an upper second)

Variable	N students	Mean
KS5 points score	31 980	35.09
IDACI score	17 315	0.17
Candidate total qualification size	32 150	3.30
Centre KS5 points score	31 990	32.26