

**School of Education**

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# The early take-up of Core Maths: successes and challenges

## Final report - September 2020

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## Foreword

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In a speech at the Royal Society in June 2011, the then Secretary of State for Education Michael Gove said: “We should set a new goal so that within a decade the vast majority of pupils are studying maths right through to the age of 18”. This was partly motivated by Nuffield Foundation research showing that fewer than one in five students in England, Wales and Northern Ireland studied any kind of maths after GCSE, the lowest levels of participation in the 24 countries surveyed. Professor Sir Adrian Smith’s 2017 review of post-16 maths education, which drew on Nuffield research, also pointed to the fundamental importance of numeracy and data skills from an economic perspective and highlighted priority areas for action.

Gove’s goal was extremely ambitious, particularly in the face of constraints imposed by available maths qualifications. One policy response in train prior to the Smith Review was the development of Core Maths, a qualification aimed at those young people who have done relatively well at GCSE (at least a Grade C or Grade 4) to supplement A-levels or vocational qualifications. In a 2014 report we identified a number of challenges to be met if Core Maths was to fulfill its potential: vigorous and sustained political backing; clear and strong signalling across higher education and amongst employers that the qualification is valued; and sufficient funding and staff for schools and colleges to deliver it well.

This report gives us the first independent analysis of what early take up of Core Maths can tell us about the extent to which these challenges have (or have not) been addressed. Some of its findings are promising. Those students who have undertaken Core Maths are generally very positive about its content and value. The schools and colleges that have decided to offer Core Maths have found sensible ways to combine it with A-levels and other complementary qualifications. The focus and approach of the qualification aligns well with demands for numeracy skills from employers and higher education institutions.

However, there are many disappointing findings. Given that we are now several years in, the range of schools and colleges offering Core Maths is frustratingly limited and this is of course reflected in low student numbers. While annual entries continue to grow slowly, this conceals a certain amount of churn, with some schools dropping the award after just one cycle of engagement. There are concerns about the status of the qualification: it is not an AS level, despite having the same UCAS tariff value; and it goes against the grain of the DfE-driven shift from modular AS-A2 level courses to linear A-levels. Funding arrangements have resulted in a shift from the intended two-year model to a more compressed approach within a single school or college year. Awareness of Core Maths remains poor, perhaps the most worrying finding given that this is a necessary (but of course not sufficient) condition for employers and universities to signal to students that they value the qualification.

The introduction of a new qualification is always difficult, especially when it sits outside the well-understood framework of GCSE and A-level. Even with consolidated and sustained government backing it can take several years of development and promotion to gain recognition and value. Core Maths has all the ingredients of a valuable addition to the qualification landscape, but this report – nearly a decade on from Michael Gove’s speech – suggests significant additional engagement is required from all quarters for it to fulfil its potential in addressing low participation in post-16 maths.

**Josh Hillman**

Director of Education, the Nuffield Foundation

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## Report headlines

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The importance of increasing post-16 mathematics participation in England is widely recognised. Stakeholders, including government, higher education, employers, and the maths education community, have associated low post-16 maths participation with poor mathematical competence and confidence amongst school-leavers and graduates. These long-running concerns led, in 2013, to the development of Core Maths qualifications in an attempt to address this deficiency.

Our study finds that Core Maths courses are valued by teachers and students who have experienced them. However, six years on from first teaching, national take-up of Core Maths remains relatively low. The nature of Core Maths, designed to sit alongside main programmes, does not easily fit into the new per-student funding regime. Institutions struggle to find attractive and cost-effective ways of including Core Maths in their curriculum provision. In addition, the continuing lack of recognition of the qualification by higher education and employers limits its appeal to students.

New qualifications take time to gain recognition and currency. Government-funded efforts to support Core Maths uptake, including the Advanced Mathematics Premium, must be intensified, and should include consideration of direct funding. Ongoing work to encourage more higher education institutions to signal the value of Core Maths as part of entry to their programmes should also continue.

The benefits afforded by Core Maths, particularly in terms of developing the ability to apply mathematics to everyday problems, are widely recognised. The development of a two-year Core Maths course equivalent in size to an A-level, and a Core Maths-type qualification at GCSE, should be seriously considered.

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# 1 Executive summary

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## 1.1 A note on the impact of COVID-19 in 2020

The data gathering and the writing of this report took place prior to the onset of the COVID-19 pandemic and the national lockdown in the UK in March 2020. Publication of the report has been delayed because of the impact of the pandemic on all sectors. However, we have not adjusted any of the reporting or recommendations.

Given the crisis, and the very likely need for schools and colleges to focus on key priorities as the pandemic eases, the future of Core Maths remains uncertain. We recognise that teachers and managers in post-16 institutions may be concentrating their efforts on main programmes, while Core Maths might remain at the margins. However, we also believe that the fact that many students have missed a lengthy period of their schooling in 2020 could be a genuine opportunity for Core Maths. Most immediately, many students in Year 11, who have missed the period including the focused study for and sitting of GCSE examinations, would benefit greatly in their post-16 studies from the opportunity to study Core Maths, which would enable them to ease back into mathematical thinking. Similarly, Year 12 students with quantitative subjects in their programme would benefit from being able to practise the mathematical elements of those qualifications within Core Maths lessons. Our work indicates that any student in that transitional period of Year 11 and Year 12 would benefit from picking up Core Maths and taking mathematics through into their post-16 programme, developing the confidence to re-engage with academic study and with critical thinking, as well as with mathematics.

As the education system readjusts, over a period of months, and perhaps years, there is an opportunity for reassessment of its priorities and essential values. There is a place for the approach and accessibility of Core Maths. We are still following its fortunes keenly.

## 1.2 Background: Core Maths and this study

Core Maths (CM) qualifications were first taught in 2014, and first examined in 2016, as a contribution towards achieving the government's policy objective of substantially increasing post-16 mathematics participation at Level 3 in England. Participation in post-16 mathematics is known to be much lower than that in other developed countries, despite recognition that mathematical skills and confidence are important for study, life, work and society.

There have been previous initiatives designed to increase participation in post-16 maths, but sustaining and growing them has proved difficult. Additional qualifications such as Use of Mathematics A-level, whilst being appreciated by individuals who were able to benefit from them, have not contributed on a national scale to increasing the numbers of post-16 students continuing with maths. Strong and sustained political backing is essential: without it, initiatives remain vulnerable. The introduction of new Core Maths qualifications, and the embedding of mathematical and quantitative skills into other post-16 qualifications, were part of wide-ranging curriculum and assessment reforms set in train by the Conservative-Liberal Democrat coalition (2010-2015) which have had significant impact on the post-16 system. It is still not clear whether the government's ongoing aim of near universal participation in post-16 maths can be achieved.

This report provides details of a three-year (2017-2020) research project, which used a mixed-methods approach, including national data (2016-2019), a set of thirteen case study institutions (2017-2019), and an online survey (2019), to investigate the successes and challenges experienced by this new addition to the post-16 landscape over its first few years of existence. The intention is to assess the likelihood that Core Maths will successfully contribute to the desired growth in post-16 mathematics participation.

## 1.3 Key findings

### *Largely positive responses to Core Maths as a course*

1. The introduction of a new course distinct from A-level Mathematics, that is designed to allow many more students to study mathematics in their post-16 career, has been broadly welcomed by school and college staff, students, and the wider mathematics education community (4.1.1). CM is well liked and highly valued by teachers and most students who have experience of it.
2. Teachers enjoy teaching CM because it is a clearly distinct qualification from A-level Mathematics (4.7). CM teachers are positive about the course, typically enjoying the greater freedom they have to allow a lesson to flow in different directions, and a lighter burden which contrasts with the pressure of hurrying through lots of content and preparing for (other) high-stakes exams (4.6.1).
3. CM is perceived by students to be less pressurised and less intense than A-level Mathematics (4.7.5). Students moving into Core Maths after experiencing GCSE Mathematics, and those moving from A-level Mathematics to Core Maths, can take a while to adjust, particularly to open-ended tasks, or where there is not one right answer.
4. The real-world, applied nature of the mathematics in CM, and the financial topics in particular, are greatly appreciated by staff and students (4.4.2). CM is perceived to be more relevant than any other maths experienced by teachers or students. CM students are generally positive about the usefulness and relevance of the mathematical skills they have developed, and the confidence they build, through taking CM.
5. The positive reception of the personal finance aspects of the course leads to a general perception that all students should be studying at least those aspects, which will help students in the future when dealing with mortgages, tax and different types of loan in their own lives, and in viewing the world with a critical eye (4.5.4).
6. Students and staff perceive that studying CM supports other subjects with a mathematical or quantitative element such as Psychology, Biology and Business Studies (4.2.4). This may be related more to the confidence and the facility with applications of mathematics which are developed, than to the specific content of a particular subject or CM specification. There is no compelling evidence from national data to suggest that studying CM enhances examination outcomes in other (A-level) subjects (4.2.6).
7. There is a perception that students who have done well at GCSE Mathematics will find CM to be an enjoyable, manageable course, even when taking it in addition to their main programme (4.4.1). Students who have taken Foundation GCSE may find it more difficult than those who have taken Higher, because they have experienced a narrower range of content. However, the accessibility of CM can bolster students' confidence in their mathematical ability, allowing students who previously struggled with mathematics at GCSE to thrive.
8. Students and teachers report that the relevance and applications of maths within CM should be made available in a corresponding pre-16 qualification at Level 2 (4.4.1).
9. According to a range of stakeholders, adult learners, on gaining their GCSE, would benefit from progressing onto CM, but currently have to fund the course themselves in order to do so (4.4.4).

### *Relatively weak national uptake of Core Maths*

10. Growth in the number of students taking CM qualifications has been steady, with uptake rising by around 2,000 per year, from 2,930 in the first cohort (2016) to 11,791 in 2020 (Figure 1). The current number of entries represents less than 2% of the annual student cohort, however, and does not match the policy aspiration of significantly increasing the number of students studying Level 3 Mathematics, and there remains considerable scope for numbers to increase further.

11. Core Maths qualifications are nationally approved Level 3 maths qualifications counting towards the Level 3 maths measure. This is a performance measure which the Technical Guide to 16 to 18 Accountability Measures, dated July 2019, states “supports our ambition for the overwhelming majority of young people in England to study maths to age 18 by 2020” (Department for Education, 2019, p.19). This measure has not been adequately used as a lever in driving CM take-up (4.1.6).
12. National data suggest that the overall growth in CM entries also hides a considerable amount of churn, where significant numbers of institutions, particularly schools, have withdrawn or paused their CM provision (4.1.5). Local decisions about its continuation are being made within some institutions on a year-by-year basis (5.14).
13. There is no evidence to suggest that numbers enrolling on CM courses threaten A-level Mathematics numbers (4.1.8).
14. The gender balance in CM participation is more equitable than in A-level Mathematics (Table 3), and has become more so over time, growing from 33.9% female in the 2016 examinations to 45.2% in 2019 (Figure 2). However, the female participation rate varies greatly from institution to institution, and may depend upon how or whether CM is aligned with particular subjects or main programmes (Figure 3).
15. There has been an apparent shift in the most popular qualifications which CM students are also studying (4.2.5). In 2016, CM students were predominantly also studying BTEC qualifications; by 2018, the most popular companion qualifications were A-levels. A significant minority of students are pairing CM with EPQ to make up what is essentially a two-year course (4.2.1). Because CM and EPQ are unequal in terms of UCAS tariff, this combination does not quite offer the equivalent exchange value of a full two-year course.
16. Survey data suggest that there are varied opinions across England as to the likely impact of the Advanced Maths Premium (AMP) on CM uptake (4.1.7). Schools with smaller sixth forms may struggle to recruit enough students to create or maintain a CM group, even with the inducement of the AMP. Colleges, with a larger student body, may be best placed to increase their provision.
17. The deliberately sector-led approach to the rollout of CM resulted in a partial coverage of the country, with those institutions already within networks being, on the whole, the ones who engaged with CM (4.7.1). Training provided by the Maths Hubs or support programmes (CMSP/AMSP) did not necessarily reach teachers who were not part of local networks. Our data suggest that it is not unusual for teachers to have embarked on teaching CM without any training at all. Teachers report having had to fend for themselves, including making their own resources in the first couple of years, though resources are now becoming plentiful, especially thanks to online platforms and social media sharing.

### ***Complexity of local implementation of Core Maths***

18. The original two-year design of the CM course lends itself well to being offered to students who wish to maintain a breadth of study in their post-16 programme, who are comfortable with the extra work this entails, and who value the usefulness of the extra skills and confidence they develop in maths, whatever other subjects they are studying (4.2.1). However, a two-year course does not necessarily suit students who are less committed to mathematics as an extra course beyond their main programme, and this can cause a retention problem, with students withdrawing from the course (4.2.2).
19. A range of data suggests that there has been a widespread shift towards teaching CM over one year (4.2.1). Reasons for this include avoiding dropout between year 1 and year 2, moving CM examinations away from main programme examinations at the end of two years, and providing a one-year option for students withdrawing from any two-year course at the end of only one year, which leaves a gap in their study programme.
20. Systemic issues are likely to continue militating against substantial growth of CM, no matter how positively students and teachers have received the course itself (4.2). The post-16 funding structure which supports

three A-levels or the equivalent leaves little room for manoeuvre for offering extra courses. The AS-like size of CM does not fit comfortably into the new linear post-16 landscape. As a result, we have seen a range of models of implementation (Table 9), as each school or college has to work out how best to manage implementation within its own constraints and according to its needs and priorities. Some institutions choose not to engage at all with the complexities of deciding how to deliver CM, and therefore do not offer it.

21. Operational issues within institutions can constrain or prescribe the CM target group (4.3). CM may be offered primarily to students who have not achieved the access grade for A-level Mathematics, or students who need to carry on with their mathematics in order to access other subjects (e.g. Psychology, Chemistry). Linking CM with other subjects can expand numbers, but can also result in students feeling resentful about CM, and mandating them to study CM as a requirement for entry onto their main programme can lead to retention issues (4.2.1, 4.2.2). Alternatively, CM may be offered as an enrichment or extension activity into which any student can opt. This strategy tends to result in small numbers, due to low student appetite for the qualification.
22. CM tends to suffer from a relative lack of status, especially when compared with A-level Mathematics, rather than being valued in its own right (4.7.5). This can be due to a perception that CM is for students for whom A-level Mathematics is not appropriate, which in turn can be dependent on how the institution markets the course, and at whom. The status problem is exacerbated by the fact that CM is half the size of an A-level, which can lead to problems in terms of a student's package of qualifications, particularly when it comes to applying for higher education.
23. CM students are typically lower attaining at GCSE in Mathematics and English Language than are A-level Mathematics students, but are higher attaining at GCSE than other Level 3 students as a whole (Figure 9 and Table 15).
24. Although the qualification is aimed at any student who has achieved a standard pass (grade 4+) at GCSE Mathematics, it is not always the case that any grade 4+ student is offered the course (4.3). The access grade in some institutions can be a 5 or higher.
25. Awareness of CM is not necessarily strong beyond the maths department, including in institutions where CM is being taught, meaning that staff are not well enough informed to advise students about the benefits of taking CM (4.2.4). There is also confusion around the nature of the qualification, which is sometimes referred to, even by maths teachers, as an AS.
26. Schools and colleges vary in their marketing strategies and messages (4.8.2). School sixth form staff in 11-18 and 14-18 schools [i.e. carriage return before 11-18] are able to inform pre-16 students about CM and its benefits. Staff in 11-16 schools are less likely to be conversant with the options available to their students going into new institutions. Further education and sixth form colleges hold open events at which they promote their courses.
27. The marketing messages to students of the benefits of doing CM do not necessarily match with their actual and eventual experiences; for example, students told that CM will help their HE applications may find that this is not the case (4.8).
28. CM pedagogy sometimes promotes a new style of thinking and working in the classroom (4.6.1). Whilst some teachers adopt an approach which is in keeping with the exploratory and open-ended methods promoted for CM, others maintain a similar style of teaching in CM lessons as in other classes (e.g. GCSE/A-level).
29. CM is being taught predominantly by mathematics specialists (4.6.1). Care is taken over who within the maths department is allocated the CM teaching. There is a general feeling in schools and colleges that the course should indeed be taught by mathematics teachers.

## *Need for greater signalling of the value of Core Maths from HE and employers*

30. Signalling from higher education institutions of the value of CM for studying at university remains weak (4.9.1). Whilst there are UCAS points for CM, the qualification itself, achieved at any grade, does not usually carry exchange value. This is a significant source of frustration amongst CM teachers and CM students. There are tentative signs of movement, albeit gradual and piecemeal, in the direction of more signalling of the value of CM by a number of HE institutions. The Universities of Bath, Sheffield and York are now making an alternative offer for specified courses to students attaining grade A or B in CM.
31. Retention on CM is negatively affected when students who initially believe that having a CM qualification, in addition to their main programme of three A-levels or equivalent, will enhance their university application discover that it may not (4.9.1). Retention problems can in turn cause institutions to withdraw their CM provision. Teachers say that, without the pull factor from HE, institutions and students will not take up CM in the desired numbers.
32. Higher education institutions are more likely to specify a particular GCSE grade in Maths than to recognise achievement in CM (4.9.1). This can lead to overstretching of post-16 resources, as students who have already achieved grade 4 or higher are retaking GCSE Mathematics to secure a higher grade for university entry.
33. Higher education admissions tutors are not yet, to any significant extent, cognisant of the benefits of CM to students who have taken the course (4.5.1). Employers are unlikely to have heard of CM, and therefore cannot be expected to understand the benefits it brings to students (4.5.3).
34. Employers and higher education representatives stress that they need individuals to come to them, not necessarily with advanced maths skills, but with fundamental mathematics skills and the confidence to use those skills fluently (4.5.3).

## **1.4 Recommendations**

Based on the study's findings, and wider considerations of the pre- and post-16 mathematics curriculum landscape, we make the following set of recommendations concerning Core Maths and post-16 mathematics more generally. We recognise that some of these recommendations have funding implications, that some of them relate to long-running issues (e.g. teacher shortages, wider societal views of mathematics), and also that some, such as the development of new qualifications, might be longer-term in nature. Acting on these recommendations would begin to overcome the challenges facing CM.

### *Signalling the value of Core Maths*

#### **Recommendation 1**

All stakeholders (schools and colleges, the Department for Education, higher education institutions, employers, awarding bodies) should recognise the need for careful signalling of the value and importance of CM. All signalling should focus on the value of studying CM in its own right in order to develop and sustain mathematical skills beyond the compulsory phase. Signalling should avoid language referring to the target group being those students not taking A-level Mathematics, since this tends to set up an unnecessary and unhelpful comparison between qualifications.

#### **Recommendation 2**

The Department for Education should ensure that the ongoing work by the Advanced Mathematics Support Programme and the Maths Hubs to increase post-16 mathematics participation be intensified. Funding for these bodies should continue in the longer term. This will help ensure, in particular, that higher education institutions continue to develop understanding of the value of CM qualifications, and begin to include them as a formal part of their admissions process.

### Recommendation 3

Ofsted could play a bigger role in signalling the value of CM to schools, colleges and even parents. Ofsted has the power to influence policy at institutional level, and could demonstrate more clearly that post-16 Level 3 mathematics participation is an important part of their remit, for example, by always including this element of provision in their inspection and reporting. Greater leverage could be exerted by making more prominent reference to the Level 3 maths measure. Her Majesty's Chief Inspector could also promote the study of CM as a key part of a broad, well-balanced post-16 curriculum.

### Recommendation 4

The Department for Education should ensure that all teaching staff, and those with responsibility for careers and pastoral care both pre- and post-16, as well as the new teaching school hubs, and local managers, are targeted with appropriate information about CM that they can pass on to staff and students as appropriate. This material might also include a range of shared strategies for developing student recruitment. Current efforts at informing relevant parties in schools and colleges about the importance of mathematics, post-16 mathematics, and CM specifically, focus largely on mathematics teaching staff, particularly those working in post-16 settings. However, the nature of CM, which is designed to support other subjects, future study, employment, and everyday life, implies that a wide range of staff in schools and colleges need to know about, and be able to advise on, the study of CM.

### Recommendation 5

In conjunction with Ofqual, UCAS should revisit the tariff for CM, and, if possible, make it equivalent to half an A-level, in line with the Extended Project Qualification (EPQ). This will help signal CM as a qualification of equal value to the EPQ, and, when paired with the EPQ, will provide the equivalent tariff of an A-level or equivalent two-year qualification.

## *Supporting the teaching, funding and availability of Core Maths*

### Recommendation 6

The Department for Education should continue and develop its strategies for improving mathematics teacher recruitment and retention. Capacity issues are likely to inhibit the growth of CM provision, particularly if it is to be taught mainly by specialist mathematics teachers. Provision in FE colleges seems to have the potential to grow, and a specially tailored approach might be needed in contexts where technical/vocational staff may be teaching post-16 maths. The Department must act to ensure that initial mathematics teacher education and continuous professional development include support and practice in CM-appropriate approaches to teaching, such as problem solving, open-ended activities, Fermi estimation, and mathematical investigation and discussion.

### Recommendation 7

The Department for Education should review the funding arrangements for CM. Currently, as an extra qualification alongside main programmes, it can be regarded by managers as an additional cost, prohibiting its uptake in some institutions. Including CM within main study programmes as a solution to the funding problem can limit a student's opportunities for progression, particularly to higher tariff HE institutions.

The Advanced Maths Premium has benefited some institutions. However, the calculation of numbers above an existing baseline is essentially unfair to those institutions who committed themselves early on to offering CM in good faith, and risks leading institutions to mandate post-16 mathematics for financial gain rather than for educational reasons. Combining financial support for CM with other Level 3 mathematics courses makes the matter even more complex. CM in school sixth forms, with naturally smaller classes, is particularly vulnerable. To ensure widespread participation, CM needs to be directly funded.

### Recommendation 8

The Department for Education should fund research to investigate exactly how institutions are using the Advanced Mathematics Premium funding to support and develop their post-16 mathematics provision.

**Recommendation 9**

The Department for Education should make CM available to adult learners at no cost, as a natural progression from GCSE. This would help to upskill the workforce across the nation with regard to quantitative skills, in line with the objectives of the Industrial Strategy (Department for Business, Energy and Industrial Strategy, 2017).

***Developing additional Core Maths-type qualifications*****Recommendation 10**

The Department for Education should consider developing a two-year version of Core Maths at Level 3, assessed at A-level standard. The current Core Maths qualifications certainly serve a purpose, and work particularly well in those institutions which find they can, as was intended, offer CM as a two-year enrichment course alongside a main study programme of three other courses. A two-year, A-level equivalent, version of CM would solve many of the challenges currently facing CM, including how it fits within the main programme of study, progression and study programme issues where it is offered over one year, and problems of funding CM as an extra course. We recognise the sensitivities around perceptions that such a two-year course would put it in competition with A-level Mathematics for students. A considerable degree of preparatory work would be necessary across schools, colleges and HE, to ensure that the purpose of an A-level-sized Core Maths is understood as being clearly distinct from the purpose of A-level Mathematics. A starting point for the design of such a two-year qualification could be the pre-existing compulsory and optional units of current specifications, but further development work needs to be done to consider the inclusion of content from emergent fields such as data science.

**Recommendation 11**

The Department for Education should consider developing a pre-16 Core Maths-type qualification at Level 2, to sit alongside the existing GCSE Mathematics. We recognise that this raises many complex and difficult issues that would need to be addressed before such a qualification could be introduced (e.g. staffing, decisions around choice/compulsion, and implications for post-16 progression). However, the longer-term benefits of a different type of GCSE Mathematics would be considerable, in terms of improving numeracy skills and mathematical confidence across the population, and in increasing post-16 mathematics uptake.

**Recommendation 12**

The Department for Education, and the wider government, should take steps to develop a more efficient and comprehensive system for managing the rollout of new qualifications. A wide range of actors, policies and programmes (e.g. the Smith Review, Industrial Strategy, Advanced Maths Premium, Advanced Maths Support Programme) have all been supportive of CM, and of increasing post-16 maths participation more broadly. However, this study has demonstrated that wider systemic issues can work against even well-designed and well-received qualifications, and that educational policymaking needs to be more coherent across the system.

**1.5 Acknowledgment**

The Nuffield Foundation is an independent charitable trust with a mission to advance social well-being. It funds research that informs social policy, primarily in Education, Welfare, and Justice. It also funds student programmes that provide opportunities for young people to develop skills in quantitative and scientific methods. The Nuffield Foundation is the founder and co-funder of the Nuffield Council on Bioethics and the Ada Lovelace Institute. The Foundation has funded this project, but the views expressed are those of the authors and not necessarily the Foundation. Visit [www.nuffieldfoundation.org](http://www.nuffieldfoundation.org).

## 2 Introduction

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Core Maths is a performance table category, and an umbrella term for a suite of relatively new Level 3 qualifications designed to increase post-16 mathematics participation in England (Department for Education, 2018). The first teaching of these qualifications took place in 2014, with first examination in 2016.

This report details the findings of a three-year, mixed-methods study funded by the Nuffield Foundation which began in March 2017. The study's overall aim is to investigate the successes and challenges facing this important and innovative addition to the post-16 curriculum in its early years of implementation, and to make evidence-based suggestions as to how the government and other agencies can best act to work towards fulfilling the policy aspiration of much greater post-16 participation rates in Level 3 mathematics.

The remainder of this section covers the relevant policy background, giving a short history of Core Maths, and summarising the wider educational and policy context. We also outline the need for this study, and provide an overview of the rest of this document.

### 2.1 Policy background: post-16 mathematics

In order to appreciate the context within which Core Maths has emerged, we review briefly the recent history of post-16 maths participation, and wider education policy changes instigated by the Conservative/Liberal Democrat coalition government (2010-2015) and taken forward by the subsequent Conservative administration (2015-2019).

It has been well known for at least a decade that England has very low rates of post-16 participation in mathematics compared to its international competitors (Hodgen et al., 2010; Hillman, 2014). A-level Mathematics has grown to become the most popular A-level of all, with 85,000 entries in 2019. Yet, looking beyond those students taking A-level Maths, there remain over 200,000 students each year with standard GCSE passes in mathematics (grade 4 or above) who cease, after taking those GCSEs, to study mathematics. This is considered an important by a range of stakeholders including the government, employers and higher education (HE).

Government and industry have long been arguing for mathematics to be more widely taught in the post-16 sector, not only because of the importance to the economy of STEM careers, but also to support a range of other employment pathways. Strong mathematics skills are said to be vital to the economy and increasingly important to a range of careers (Hodgen and Marks, 2013). According to the UK government, generating mathematically competent and confident workers is central to boosting the long-term productivity of the economy (HM Treasury, 2016). The resulting political ambition has been that the majority of, if not all, students should be studying maths in some form up to the age of 18, within the foreseeable future (BBC News, 2011; Department for Education, 2013).

There is also a strong argument that a good level of mathematical and statistical literacy is increasingly important in enabling citizens to participate fully in a modern, scientifically and technologically developed, democratic society (British Academy, 2012). The level of numeracy in the adult population is regarded as being far too low: for example, in 2019, the charity National Numeracy estimated that the numeracy level of over half the population is roughly equivalent to that expected of a primary school child.<sup>1</sup>

Alongside these problems, there has been a longstanding concern within the HE sector that undergraduate students lack the mathematical skills, knowledge, fluency and confidence necessary for them to benefit fully from the courses onto which they enrol (Advisory Committee on Mathematics Education, 2011). There is also good evidence that the quantitative demands of HE courses are on the increase, with statistics in particular becoming more widely taught, for example in the social sciences. ACME (2011) estimated that 330,000 HE entrants annually would benefit from having had recent experience of studying some advanced (post-GCSE) mathematics, including statistics, but that fewer than 125,000 had done so.

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1 [https://www.nationalnumeracy.org.uk/sites/default/files/building\\_a\\_numerate\\_nation\\_report.pdf](https://www.nationalnumeracy.org.uk/sites/default/files/building_a_numerate_nation_report.pdf)

The UK government's ambition has been stated as: "to look at teaching maths to 18 for all pupils" (HM Treasury budget, 2016). Yet there is a clear tension between the avowed need for more students to continue studying maths beyond GCSE and through the post-16 phase, and the dearth of opportunity for them to do so.

A-level Mathematics itself was revised, as was the GCSE in Mathematics, as part of the wider curriculum reforms of the coalition government. There has been a move to include more problem solving and more advanced content in GCSE Mathematics, and, as a consequence, an increase in the difficulty of the examinations and a lowering of grade boundaries.<sup>2</sup> The rationale behind this change was to smooth the transition between GCSE and post-16 mathematics. An unintended consequence, however, may have been to dissuade some students from enrolling on A-level Mathematics given the more challenging mathematical experience pre-16.

For students who wish to take mathematics post-16 but who do not wish to, or who cannot, take A-level (and AS<sup>3</sup>) Mathematics, and possibly A-level (and AS) Further Mathematics, the options have historically been limited. The most significant of the initiatives which have come and gone is probably the Use of Mathematics qualification, available at AS and (with pilot status) at A-level. It ran between 2009 and 2018 and shared many of the aims of Core Maths, namely to promote applications of mathematics in realistic contexts, and develop confidence and fluency. It was well liked by those who taught or studied it, the full A-level offering students the opportunity to study mathematics for two years and gain a qualification which would be included within university applications and offers. However, it was taught in relatively few institutions, at least in part due to the restricted numbers placed on it by its pilot status, and it is now withdrawn.

There is also A-level Statistics, dropped by AQA in 2016 (only 731 students sat AQA's A-level Statistics in 2015-16) and resurrected, following successful lobbying from the Royal Statistical Society and other bodies, by Edexcel. Presenting strong arguments about the importance of data handling and statistical skills in the workplace and in contemporary society, and the importance of having a full two-year A-level alternative to A-level Mathematics, the advocates of this qualification hope that it will grow from its base of relatively few applicants.<sup>4</sup>

Other additional or alternative maths options have included Free Standing Maths Qualifications (FSMQs), short modules in aspects of mathematics, available at Level 2 and 3. Most of these have been discontinued as the range of qualifications included in performance tables has been tightened. OCR continues to offer one unit, in Additional Mathematics.<sup>5</sup>

Another strategy has been implemented in the attempt to ensure the continued study of maths beyond GCSE: the embedding of maths and quantitative skills into other curriculum qualifications, both academic and vocational. A specified and mandatory percentage of the assessment for a range of subjects now requires the use of mathematical skills equivalent to Level 2 or above, the standard of Higher tier GCSE Mathematics. For example, this includes at least 10% of the assessment in A-level Biology and A-level Psychology, at least 20% of the assessment in A-level Chemistry, and at least 40% in A-level Physics (Department for Education, 2014). A third of non-mathematics A-levels now include more contextualised mathematics and statistics in synoptic assessments (Department for Education, 2014; Smith, 2017; Adkins and Noyes, 2018). The policy of 'embedding' reflects the argument that students might learn mathematics more effectively when incorporated as part of their disciplinary studies (Adkins and Noyes, 2018).

In summary, there is a widely expressed concern that more students need to continue studying maths post-GCSE, but also an acknowledgement that opportunities for them to do so have been lacking. Attempts to address this situation thus far have not proved successful. With this background in mind, we now turn to the advent and early years of Core Maths.

<sup>2</sup> <https://www.tes.com/news/lower-grade-boundaries-maths-gcse-resit-exam-spark-concern>

<sup>3</sup> Advanced Subsidiary level, taken at the end of year 1 of the two-year A-level course.

<sup>4</sup> <https://www.statslife.org.uk/features/3071-why-we-need-a-level-statistics>

<sup>5</sup> <https://www.ocr.org.uk/qualifications/fsmq/>

## 2.2 The introduction of Core Maths qualifications

In 2013, the coalition government embarked on the development of a new set of qualifications, collectively known as 'Core Maths' qualifications, as a potential solution to the post-16 maths participation problem (Department for Education, 2013). Core Maths was originally intended to be taught over two years alongside a student's main study programme (Department for Education, 2013). Core Maths qualifications are equivalent in 'size' to AS-levels, in terms of guided learning hours (Department for Education, 2015) and the number of points they attract under the UCAS tariff.<sup>6</sup>

One of the more innovative aspects of Core Maths is its focus, less on learning new mathematical content (e.g. more advanced techniques), and more on building fluency and confidence in skills already learned at GCSE, and on developing the ability to tackle real-world problems in context with relatively simple mathematical techniques. The policy intention was that almost all post-16 students not doing other Level 3 mathematics courses such as A-level Mathematics could benefit in a number of ways: Core Maths would help them maintain their mathematical skills over the 16-19 period before progressing into HE or employment, and would also directly support subjects they might go on to study in HE, particularly those with a specific mathematical/quantitative element (e.g. Biology, Geography, Business Studies).

First teaching began somewhat experimentally in the autumn term of 2014, before the awarding bodies had even finalised their specifications, in over 150 Early Adopter schools and colleges. Centres whose most recent Ofsted inspection was at least Good could apply to become Early Adopters.

To begin with, five specifications of this Level 3 certificate were available:

- Mathematical Studies (AQA), which has a common Paper 1, and three Paper 2 options - Statistical techniques, Critical path and risk analysis, Graphical techniques
- Quantitative Reasoning or Quantitative Problem Solving (OCR). Paper 1 is common to both versions, but there are two Paper 2 options. These specifications were renamed in 2019 as Core Maths A and B respectively
- Mathematics in Context (Edexcel)
- Using and Applying Mathematics (City & Guilds)
- Mathematics for Work and Life (Eduqas)

In 2019, a further specification became available:

- Mathematics for Everyday Life (NCFE), which has particular vocational foci.<sup>7</sup>

In 2014, the Core Maths Support Programme (CMSP), a government-funded initiative, was established to encourage a sector-led approach to embedding Core Maths in the post-16 curriculum, working with institutions to help raise the profile of the new qualifications and support their effective teaching. A team of five regional advisors and 35 Core Maths leads offered professional development, initially to the Early Adopter institutions and subsequently to any centre offering or contemplating offering CM. A group of 32 regional Maths Hubs, run by the National Centre for Excellence in the Teaching of Mathematics (NCETM), each led by an outstanding school or college, was also established in 2014, as a forum for collaborative networks of maths education professionals to develop and share good practice. A combination of these bodies ran training and meetings for teachers. This period also saw the publication of influential reports on post-16 mathematics in England by the Higher Education Academy (HEA) (Hodgen et al., 2014) and the Nuffield Foundation (Hillman, 2014).

The CMSP contract came to an end in July 2017. The Core Maths leads had usually been balancing that role with teaching or other contracts, and many of these individuals, who had developed expertise in CM and CM support, moved on or returned to their roles in schools.

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<sup>6</sup> [https://www.ucas.com/file/259341/download?token=GXu\\_Pq-H](https://www.ucas.com/file/259341/download?token=GXu_Pq-H)

<sup>7</sup> <https://www.ncfe.org.uk/blog/new-core-maths-qualification>

A hiatus followed, during which it is possible that any momentum driving Core Maths forward was weakened or lost. This coincided with the long-awaited publication, in July 2017, of the Smith Review (Smith, 2017) and also the publication, in November 2017, of the government's Industrial Strategy White Paper (Department for Business, Energy and Industrial Strategy, 2017). These documents signalled, from government, business and the maths education community, what they considered to be the high value of maths and the importance of increasing post-16 maths participation.

The Department for Education saw an opportunity to combine two programmes together when the funding for the Further Maths Support Programme (FMSP) reached its end, and in June 2018 the FMSP became the Advanced Maths Support Programme (AMSP<sup>8</sup>) with a remit covering support for Mathematics and Further Mathematics A-level as well as Core Maths. Core Maths had been without direct support for almost a year; many of those who had worked to develop Core Maths teaching across England had been lost; and those working for the FMSP had to get up to speed very quickly with Core Maths in order to begin the task of promoting the course and training teachers from September 2018.

An important part of the CMSP's and then the AMSP's role has been to seek out and share good practice with regard to the teaching of CM. Case studies of centres where Core Maths has been successfully implemented are available on the STEM Learning website, which hosts the legacy CMSP collection,<sup>9</sup> and on the AMSP website.<sup>10</sup>

Having described the early development of Core Maths, we move on to outline the wider education policy context during this period. It is important to acknowledge a number of factors which continue to impact on the fortune of these new qualifications.

## 2.3 The wider post-16 landscape

The introduction of Core Maths into schools and colleges, as an enactment of the policy initiative, has come at a time of far-reaching change in the post-16 educational landscape in England. In 2013-14, at the inception of Core Maths, the post-16 curriculum model and funding structure were very different from the curriculum model and funding structure which now exist in 2020.

Under the former post-16 system, which was in place in 2013-14, per-qualification funding supported a typical pattern for A-level students of taking four courses in year 1, and, after taking AS exams in all four at the end of year 1, dropping one subject and going into year 2 with three subjects. We heard this referred to in our case study centres as the 4 + 3 model. BTEC students could also gain accreditation after only one year and cease studying that particular subject.

Post-16 funding now works on a per-student basis,<sup>11</sup> supporting 600 Guided Learning Hours (GLHs) per year per student on average. Of that, 540 hours are usually designated as for the three A-levels (or equivalent) of the main study programme at 3 x 180 hours per year (Education and Skills Funding Agency, 2017), and the remaining 60 hours are for PEEP (Planned Employability, Enrichment and Pastoral) time.

Furthermore, the curriculum and assessment structure has changed. In a move towards what is known as linearity, A-levels are no longer modular, and the AS has been decoupled from the A-level, meaning that AS examinations no longer feed into the full A-level result. A-level assessment is by terminal examination taken at the end of a two-year course, and two-year programmes have become the norm.

There has subsequently been a steep fall in the number of AS entries across the country: AS-level entries reduced by a factor of 10 or so between 2015 and 2019.<sup>12</sup> Of our case studies, the majority have stopped routinely offering their students the chance to take AS exams, the entry costs of which can run into the tens of thousands of pounds in an institution, and can no longer be afforded or justified.

<sup>8</sup> <https://amsp.org.uk/>

<sup>9</sup> <https://www.stem.org.uk/resources/collection/416708/core-maths-case-studies>

<sup>10</sup> <https://amsp.org.uk/uploads/files/19d51d04eef914a9c0ace6d5aaaa9daf.pdf>

<sup>11</sup> <https://www.gov.uk/guidance/16-to-19-education-funding-guidance>

<sup>12</sup> <https://results.ffteducationdatalab.org.uk/as-level/all-subjects.php?v=20190822.2>

These major reforms have left schools and colleges with a 3 + 3 model; that is, of three funded two-year linear courses, or the equivalent in BTEC or other vocational/technical qualifications. There is little or no specific funding for teaching further qualifications like Core Maths, which is an AS-sized qualification in an environment in which the AS has rapidly disappeared. Smith (2017) highlighted that the funding of Core Maths as a course taken in addition to students' main programme needed urgent attention if numbers were to grow substantially. The continuing growth and success of the Extended Project Qualification (EPQ),<sup>13</sup> which, as an extra qualification, sits in a similar post-16 curriculum space to Core Maths, has been possible in large part because it is an independent project, not requiring the funding of curriculum teaching time.

The need to fund teacher time for the new Core Maths qualifications adds to the pressures faced by institutions as a result of longstanding staffing shortages, which have impacted particularly strongly on mathematics.<sup>14</sup> This situation has been exacerbated by a move which has diverted significant amounts of teacher time into the introduction of a requirement for students not achieving a grade 4 in GCSE Mathematics by the age of 16 to re-enrol on the course post-16.<sup>15</sup>

In the 2017 autumn budget, money was announced for post-16 mathematics participation, in an attempt to support growth. This included an Advanced Maths Premium, which, broadly speaking, promised £600 per additional Level 3 mathematics student per year per A-level sized qualification above a defined baseline.<sup>16</sup> We use the first tranche of data relating to this initiative later in this report, to consider its potential impact.

Finally, the DfE introduced an additional accountability measure within the schools and colleges performance table, effective from summer 2017, to promote the continuation of maths study in the 16-19 phase. This measure shows the percentage of the students in scope (the potential pool of students) who achieve an approved Level 3 maths qualification, including Core Maths, AS or A-Level Maths, or an International Baccalaureate Level 3 maths certificate. The DfE hoped that, by 2020, the majority of students would be included in either this measure, or, for those retaking GCSE Maths, the maths progress measure (DfE, 2016).

All the issues described here which are present within the broader context are relevant, in a variety of ways, to the likely long-term success of Core Maths, and we shall return to them over the course of this report.

## 2.4 The need for this study

A number of recommendations in Professor Sir Adrian Smith's review of post-16 mathematics in England (Smith, 2017) highlighted the importance of the role of Core Maths in facilitating an increase in post-16 mathematics participation in England. Given the complexities of the post-16 system in England as described above, and the relatively novel content, structure and approach of Core Maths compared to A- and AS-level qualifications, there is an evident need for research and evaluation of how the national uptake of this new qualification is developing in its early years of existence. There are obvious questions about who is studying Core Maths, who is teaching it, why institutions do, or do not, add it to their curriculum offer, and what perceived benefits accrue for students, institutions and other stakeholders. Ultimately, the important question for policy makers is whether Core Maths is likely to succeed, as intended, in increasing significantly the number of students studying mathematics at Level 3 in England. The focus of this study is on providing robust evidence so that this question can begin to be addressed.

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<sup>13</sup> <https://qips.ucas.com/qip/extended-project-qualification-epq>

<sup>14</sup> [https://www.nuffieldfoundation.org/wp-content/uploads/2018/06/Within-school-allocations-of-maths-teachers-to-pupils\\_v\\_FINAL.pdf](https://www.nuffieldfoundation.org/wp-content/uploads/2018/06/Within-school-allocations-of-maths-teachers-to-pupils_v_FINAL.pdf)

<sup>15</sup> <https://www.gov.uk/guidance/16-to-19-funding-maths-and-english-condition-of-funding>

<sup>16</sup> <https://www.gov.uk/guidance/16-to-19-funding-advanced-maths-premium>

## 2.5 Overview of the remainder of the report

The rest of the report consists of the following sections:

| Title                                                             | Description                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>3. Study aims and methodology</i>                              | Details the research questions and the methodology employed in the study.                                                                                                                                                                                                                                                                                                                     |
| <i>4. Main findings</i>                                           | <p>Contains all the empirical findings from the study. Includes analysis of a range of national data (NPD, awarding body, Jisc,<sup>17</sup> and Advanced Maths Premium data), online survey data and all case study and stakeholder interview data.</p> <p>Structured by key themes, based on the original purposes and intentions behind the introduction of Core Maths qualifications.</p> |
| <i>5 Case study vignettes: illustrations of CM implementation</i> | Rich illustration, from our case study institutions, of the nature of the institution and its context, how Core Maths is positioned and implemented within its post-16 curriculum, and how provision developed over the time of the study.                                                                                                                                                    |

<sup>17</sup> Jisc provides data on participation and attainment in UK higher education.

## 3 Study aims and methodology

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The overall aim of the study is to assess the early successes of Core Maths in contributing to post-16 mathematics participation, and the challenges facing its implementation and growth, and thence to understand better the underlying factors driving decisions about Core Maths, both at individual and institutional level. Based on what we have learned from our findings, we also make suggestions as to how the government and other agencies might ensure that the policy goal of a large uplift in post-16 mathematics study at Level 3 could be realised and sustained.

The original research questions to be investigated in the study were as follows:

### 3.1 Research questions

- RQ1.** What does the uptake of CM look like across England and how is this developing over its first three years? In other words, who is doing (or not doing) CM in terms of demographic profile, particularly prior attainment, gender and socio-economic status, but also pre-16 qualifications, other post-16 qualifications being studied? How is this changing over time?
- RQ2.** To what extent does the study of CM enhance attainment in other subjects (e.g. the sciences, Geography, Business Studies, Psychology and Economics)?
- RQ3.** How are schools acting to ensure the success of CM terms of access (who could do CM?), participation (who is doing CM?) and attainment (how do they do?)? What barriers do schools report in these regards?
- RQ4.** Why are students choosing (or not choosing) to study CM, what are student views and experiences of it, and what do students intend to do post-18?
- RQ5.** Who is teaching CM, and what are their experiences of this in terms of views on the qualification itself, and quality of support they receive (e.g. continuing professional development)?
- RQ6.** What are other stakeholders' views on CM? What, if anything, do they think needs to be done to ensure the longer-term national success of CM?

### 3.2 Methodology

The study has a mixed-methods, longitudinal research design with four main strands outlined as follows.

#### 3.2.1 Analysis of national data (RQ 1 and 2)

This is secondary data analysis using three successive Key Stage 5 (Level 3) NPD cohorts in England (2016-2018) linked to Key Stage 4 and census data. The longitudinal nature of the study allows us to investigate how the uptake of CM has developed over its early years and, whilst we draw on all three NPD cohorts for longitudinal findings, we focus on the most recent NPD data available from 2018 for detailed analysis.

We use descriptive and modelling techniques to investigate patterns of access to and uptake of CM, both at the school and the individual level. We also investigate, at the student level, factors associated with participation in Core Maths, including prior attainment, gender, and socio-economic status. These investigations include comparative analysis of students doing and not doing CM, and how this factor might influence attainment outcomes in other subjects popular with Core Maths students, such as the sciences, Geography, Business Studies, and Psychology.

To bolster our quantitative analysis, we also draw on other nationally available data, where appropriate, e.g. awarding body data between 2016 and 2020, and data from the first tranche (2019) of funding relating to the Advanced Maths Premium.<sup>18</sup> We also use Jisc data to track the first CM cohort into higher education to examine the types of higher education courses and institutions into which CM students are progressing. Over the course of the study, we have had the chance to investigate two possible sets of CM students going into higher education (HE): those who completed

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<sup>18</sup> We note that the NPD data has around 4% of Core Maths students missing compared to the aggregated awarding body data, possibly because the NPD does not always include qualifications taken in independent schools.

CM in 2016 and (potentially) went into their first year in HE in 2016-17, and the following cohort who completed KS5 in 2017 and entered HE in 2017-2018. Given the complications and delays associated with requesting data, and following DfE advice to request non-linked data, we are able here to present analysis of HE data only, in isolation from linked KS5 data. The data analysed are from a first-year census in HE, containing a range of student personal characteristics, together with course and institutional information. A high proportion of some variables (e.g. socio-economic measures) is missing and so analysis of these has been omitted.

### 3.2.2 Case study institutions (RQ 3, 4 and 5)

This qualitative strand explores the perspectives and experiences of staff and students within 13 English schools and colleges where Core Maths has been offered. Over 40 institutions were initially identified as potential case studies via a variety of networks, including the Maths Hubs, and from institutions' websites. Institutions were approached in turn to take part, with a view to achieving a broad representation of the different types of post-16, Level 3 provision which exist in England, and a satisfactory regional spread. The final list of centres which agreed to participate, with pseudonyms to protect anonymity, is shown in Table 1 below, along with details of the centres' location, the duration of their CM course, and the awarding body specification used. The part of each institution's name which indicates its type is retained. Throughout this report, we use abbreviations in relation to our case studies, as follows:

**UTC:** University Technical College

**FEC:** Further Education College

**SFC:** Sixth Form College

During the account of our findings, case study schools, whether academy, high school or comprehensive school, are referred to by their pseudonym only, their particular school sub-type being omitted for the sake of brevity.

| Case study institution           | Institution type           | Region of England         | Core Maths specification | Length of course (years) |
|----------------------------------|----------------------------|---------------------------|--------------------------|--------------------------|
| <b>Ball Comprehensive School</b> | 11-18 school               | North East                | AQA                      | 2                        |
| <b>Bismut Academy</b>            | 11-18 school               | East Midlands             | OCR                      | 1                        |
| <b>Donaldson High School</b>     | 11-18 school               | West Midlands             | AQA                      | 2                        |
| <b>Lions Academy</b>             | 11-18 school               | East Midlands             | OCR                      | 1                        |
| <b>Mumford High School</b>       | 11-18 school               | Yorkshire and Humberside  | OCR                      | 2                        |
| <b>Palis High School</b>         | 11-18 school               | London and the South East | Edexcel                  | 2                        |
| <b>Coates Studio</b>             | 14-19 studio school        | North West                | AQA                      | 1                        |
| <b>Rousseau UTC</b>              | 14-19 UTC                  | West Midlands             | AQA                      | 2                        |
| <b>Arnold College</b>            | General FE College         | West Midlands             | AQA                      | 1                        |
| <b>Jones College</b>             | General FE College         | North West                | AQA                      | 1 and 2                  |
| <b>Dickenstein SFC</b>           | Sixth Form College (16-19) | Yorkshire and Humberside  | OCR                      | 1                        |
| <b>Mori SFC</b>                  | Sixth Form College (16-19) | North East                | Edexcel                  | 1                        |
| <b>Viana SFC</b>                 | Sixth Form College (16-19) | North West                | AQA                      | 2                        |

**Table 1: Case study centres teaching Core Maths**

The first round of data collection took place in September/October 2017, to gather views at the start of the academic year. Semi-structured interviews were conducted with teachers, and senior leaders responsible for institutional curriculum policy, focusing partly on relevant issues identified from the literature, but also allowing participants to talk freely about their experiences of and perspectives on Core Maths and the broader context. Individual or group interviews were carried out with CM students and, in some instances, with former CM students or non-CM students.

A follow-up visit took place in the summer term of 2018, where we were able to meet with students who were either coming to the end of, or halfway through, their CM course. We conducted second interviews with some of the teachers and managers we had met before, and also interviewed new respondents. One case study institution dropped out of the study at this point.

A year later, in the summer of 2019, we revisited all but one of the remaining twelve case studies. It was not possible to arrange a visit to the twelfth case study.<sup>19</sup>

In total, we interviewed 121 students and 53 members of staff over the course of the study, many of them twice or even three times. All data were transcribed and coded, and thematic analysis was carried out using inductive and deductive approaches.

During case study visits, quantitative questionnaires (see Appendix for an example) were also given to Core Maths students, asking them about their experiences of their mathematics lessons, and their attitudes towards mathematics (Homer et al., 2020).

We present detailed portraits of each case study in a later section of this report (5).

### **3.2.3 Other stakeholder views (RQ 6)**

Over the course of the study, in the qualitative strand, we have interviewed a range of stakeholders, beyond those in institutions teaching CM. These include: teachers and managers in institutions which have chosen not to teach CM; Maths Hub leads; employers; members of mathematics education support networks such as the Advanced Maths Support Programme; admissions staff in HE; local government officials; awarding bodies and UCAS; Ofqual and Ofsted. A full list of stakeholders interviewed (anonymised) is provided in the Appendix.

### **3.2.4 Online survey to Level 3 providers (all RQs)**

In early 2019, informed by the emergent findings from the various strands of the study, we developed an online survey targeted at Level 3 providers with an interest in post-16 mathematics. This was designed to probe the extent to which the findings generated so far had wider applicability. The survey was made live in May 2019, with four-weekly reminders being sent out twice to an extensive email contacts list, which included all Maths Hubs across England and members of other networks we developed over the course of the study. A final reminder email was sent in early July 2019, and the survey was closed in mid-August 2019 with 164 responses from 132 separate institutions, 108 of whom were offering CM in the academic year 2018-19. The other responses were almost all from other schools and colleges who were not teaching CM at that time. Data were analysed using standard descriptive techniques, and appropriate graphs. The Appendix provides more details of the questions asked, a full summary of responses, and the survey structure.

## **3.3 Ethics**

This study was subject to ethical review and received a favourable opinion by the appropriate Faculty Research Ethics Committee at the University of Leeds on 18th January 2017.

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<sup>19</sup> The methodological difficulties we encountered were due, we think, to the fact that our original contacts in the two centres moved on from the institutions during the course of the study.

### 3.4 Structure of findings

In the next section, we present what we have found to be the successes of CM, and also the challenges it has faced and continues to face, in light of the original motivations and drivers of the development of this new qualification type. In order to organise the findings, we refer to Department for Education documentation advising on the development of CM qualifications, to find the stated intentions and purposes behind CM. It is possible to match the themes which have emerged from our data with the following key text, taken from the Core Maths Technical Guidance, 2018, p.3-6 (Department for Education, 2018).

*The introduction of this new category of qualifications for the purpose of performance tables was designed to address the issue of poor progression in mathematics from age 16 by offering an opportunity for students not studying AS or A level mathematics to study a Level 3 mathematics course alongside their main programme of study.*

*'Core Maths' is a performance table category which signifies mathematical qualifications suitable for those with a grade 4 or above in GCSE maths at age 16 who are not taking AS/A level maths or a Level 3 International Baccalaureate (IB) mathematics certificate as part of their 16-18 programme.*

*Core Maths qualifications should consolidate and build on students' mathematical understanding and develop further mathematical understanding and skills in the application of maths to authentic problems, thereby offering progression from GCSE mathematics.*

*Qualifications should provide a sound basis for the mathematical demands that students will face at university and within employment across a broad range of academic, professional and technical fields. Core Maths courses should prepare students for the varied contexts they are likely to encounter in vocational and academic study and in future employment and life, for example, financial modelling and analysis of data trends. As such, Core Maths qualifications should foster the ability to think mathematically and to apply mathematical techniques to a variety of unfamiliar situations, questions and issues with confidence. Core Maths qualifications are distinct from AS and A level mathematics.*

*A clear statement of purpose will help students make informed decisions, ensuring that they are fully aware of what the qualification offers.*

*In order to count in performance tables as Core Maths, qualifications should have allocated to them at least 180 Guided Learning Hours (GLH) and have a Total Qualification Time in excess of 180 hours. Qualifications of this size should provide sufficient time to develop mathematical skills to a higher level. Demand from higher education is critical to the success of Core Maths. Qualifications with a minimum size of 180 GLH are more likely to have currency in higher education than smaller qualifications.*

The next section of this report presents our findings under the following set of headings, which derive directly from the guidance text quoted above:

- 4.1 Core Maths is designed to address poor progression rates into post-16 mathematics
- 4.2 Core Maths offers opportunities for Level 3 mathematics study alongside main programme
- 4.3 Core Maths is a qualification for those with GCSE Maths grade 4 and above
- 4.4 Core Maths builds on GCSE, offering progression to authentic applications of mathematics
- 4.5 Core Maths prepares students for the range of contexts to which they will progress
- 4.6 Core Maths develops mathematical thinking and confidence
- 4.7 Core Maths qualifications are distinct from A-level Mathematics
- 4.8 Core Maths purposes are clearly communicated to students
- 4.9 Core Maths is dependent on HE demand

## 4 Main findings

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### 4.1 Core Maths is designed to address poor progression rates into post-16 mathematics

**The introduction of this new category of qualifications for the purpose of performance tables was designed to address the issue of poor progression in mathematics from age 16**

(Core Maths: Technical Guidance)

#### 4.1.1 A welcome opportunity

There is a strong positive message from teachers about CM, in terms of their experiences of teaching it, and how students respond to it. Teachers comment widely that, in their experience, students do enjoy it and benefit from it. One CM teacher at Early Adopter Lions says, “I love Core Maths”.

Core Maths is described variously by teachers as “useful”, “common sense maths”, “important”, “valuable”, “fresh” and “fun”, and “a great course”. Teachers speak of its “academic worth” in terms of use value, such as in helping the students with the quantitative aspects of other numerate subjects and understanding more about the economic aspects of life. Teachers and managers say that Core Maths provides a “different avenue” for students, and that it is “sensible to offer” Core Maths as it “fills the gap nicely”. They believe Core Maths is “really good for the students” and are sure that “we’re doing something good for the kids.” Mumford’s teachers and Donaldson’s Head of Maths all told us that teaching CM had changed them as a teacher. The Head of Maths at Coates Studio points out that it is a selling point for a school advertising for a new teacher, that there is now an additional opportunity to teach maths at Level 3 besides teaching A-level Maths, and that they will include it in their forthcoming advert for a new maths teacher. Teachers and managers who believe in CM actively try and promote CM, or “agitate”, as one puts it, amongst the wider staff body across the institution.

Students who complete the course are also, on the whole, very positive. They talk about carrying on doing some maths because they find it interesting and enjoyable, often adding that CM was not too challenging and so would not take too much time away from studying for their other qualifications. Some students had a positive message about CM complementing their other subjects, while others wanted to keep maths in their portfolio when their other subjects were not STEM subjects. Some taking CM specifically as an extension or enrichment activity said they would rather take maths in school or college than do sport, or any other extra-curricular activity, which they could do in their own time instead. Students generally saw CM as being a good thing to do, and may have had encouragements from their parents who were keen that they should pursue maths further than GCSE.

*“Everyone should do this. Like, the people that aren’t doing A-level and finish GCSE, everyone should do this, if they pass their GCSEs... It’s really relevant”*

(Arnold FEC student)

Any post-16 institution can, in principle, offer Core Maths in combination with any study programme. Across our case studies, positive reactions to the course and its benefits were common to all types of institution. The Principal, Assistant Principal and maths team at Dickenstein SFC are keen to make Core Maths a positive addition to their curriculum offer. As the Principal says:

*“It [Core Maths] supports main programme, it supports student progression to university, it may very well be the difference between a student enrolling here and enrolling elsewhere”*

The Head of Maths at Mumford also believes that offering Core Maths could make the school more appealing to prospective students, and the Head Teacher of Donaldson High School is very pleased to be able to offer Core Maths while competitor institutions do not.

Having a CM qualification shows a student has continued with some maths beyond GCSE. The Head of Maths at Donaldson says the CM qualification, or a Level 2 version, should be included at Key Stage 4. He says he is teaching better and more relevant maths when teaching CM than when teaching GCSE; his description of CM lessons is notable for vocabulary of usefulness and enjoyment of maths (see vignette 5.8).

At Lions, the Vice Principal considers Core Maths as a success, since the qualification has broadened students' choices, enabling them to continue studying maths, and enhancing their chances of progressing:

*"It gave those students, different pathways... it gave students a qualification that we were successful with as well, so I mean obviously, as a school, you are bound by results, not just from the point of view of getting your, the school the best results, but also from getting the students the best results that allows them to move on to wherever they need to go... the Core Maths allows us to do that."*

Within our online survey data, the general feeling of respondents was that the experience of teaching CM had been positive (89.7% being at least positive in this regard):

*"Students and teacher both like the course, would be more be positive though if we could recruit more students."*

(Maths teacher in a school)

Respondents were also asked about the future of CM in their institution, with attitudes generally positive (79.2% at least positive). In terms of the future of CM nationally, attitudes were slightly less positive (though the majority, 73.0%, were still at least positive), and there was some variation in responses to this question by type of institution (e.g. FE colleges were more positive about the future, followed by schools and then sixth form colleges – 100.0%, 69.6% and 55.0% at least positive respectively).

#### 4.1.2 National numbers and growth

This sub-section focuses on quantitative data on the key issue of national uptake: what does growth look like in the contribution of CM to post-16 mathematics participation since its introduction in 2014?

National figures from the awarding bodies show a steady increase over the five assessment years 2016 to 2020 (Figure 1):<sup>20</sup>

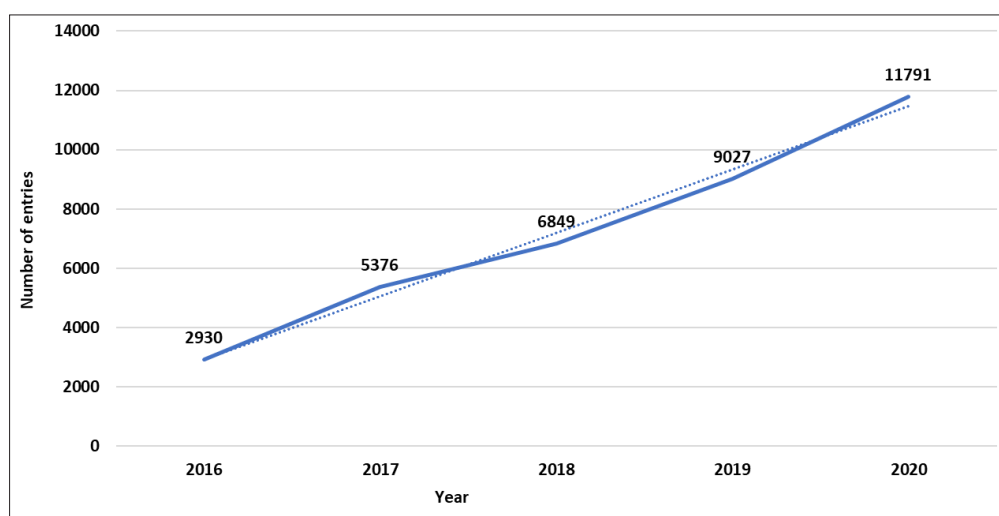


Figure 1: Aggregate awarding body entry figures for Core Maths

<sup>20</sup> Thanks to Mick Blaylock and Stella Dudzic for collating this additional data.

The linear fit in Figure 1 is extremely good ( $R^2=0.99$ ) which indicates that the increase per year in CM entries has been quite constant at around 2,000 per year (see 4.1.8 for a discussion on the likely impact of CM growth on A-level Mathematics entries).

In this and later sub-sections, we divide the most recently available (2018) NPD cohort into three groups to allow a comparative analysis across a range of characteristics. These groups are Core Maths students, A-level Mathematics students, and all other students who were awarded at least one Level 3 qualification in 2018, as shown in Table 2. The aim here is to provide insight into the nature of who is typically studying CM, and how this might compare with other groups of Level 3 students.

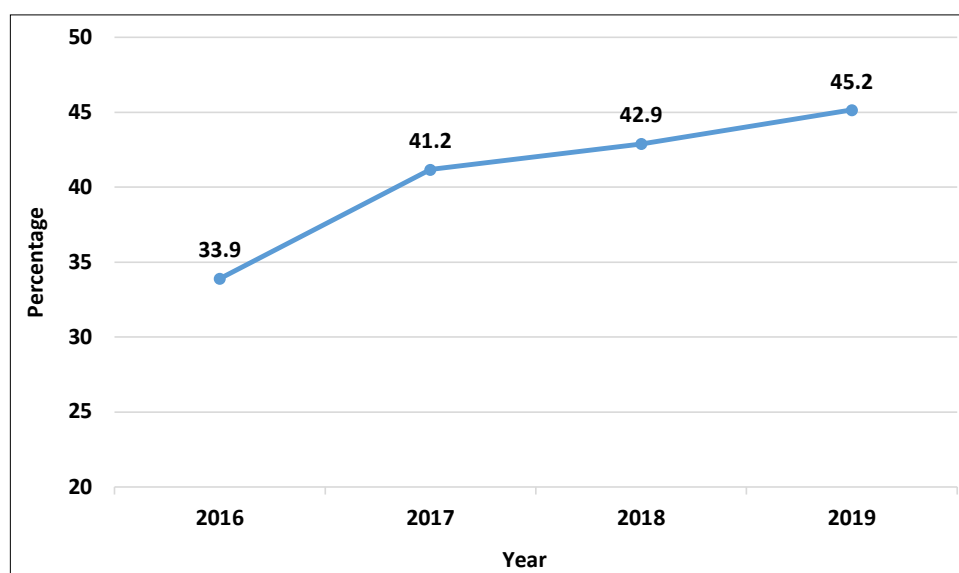
| Group                      | Frequency      | Percent      |
|----------------------------|----------------|--------------|
| <b>Core Maths</b>          | 6,561          | 1.0          |
| <b>A-level Mathematics</b> | 81,963         | 12.3         |
| <b>Other</b>               | 575,993        | 86.7         |
| <b>Total</b>               | <b>664,517</b> | <b>100.0</b> |

**Table 2: Three groups of students awarded Level 3 qualifications in 2018 (NPD)<sup>21</sup>**

Table 2 shows that CM students make up 1% of all students awarded a Level 3 qualification in 2018. In other words, as of 2018, CM uptake is small relative to the number of students in the full Level 3 cohort.<sup>22</sup>

### 4.1.3 Participation by gender

Aggregate awarding body data on the split by gender in entries shows a trend over time towards more equitable participation in CM (Figure 2).

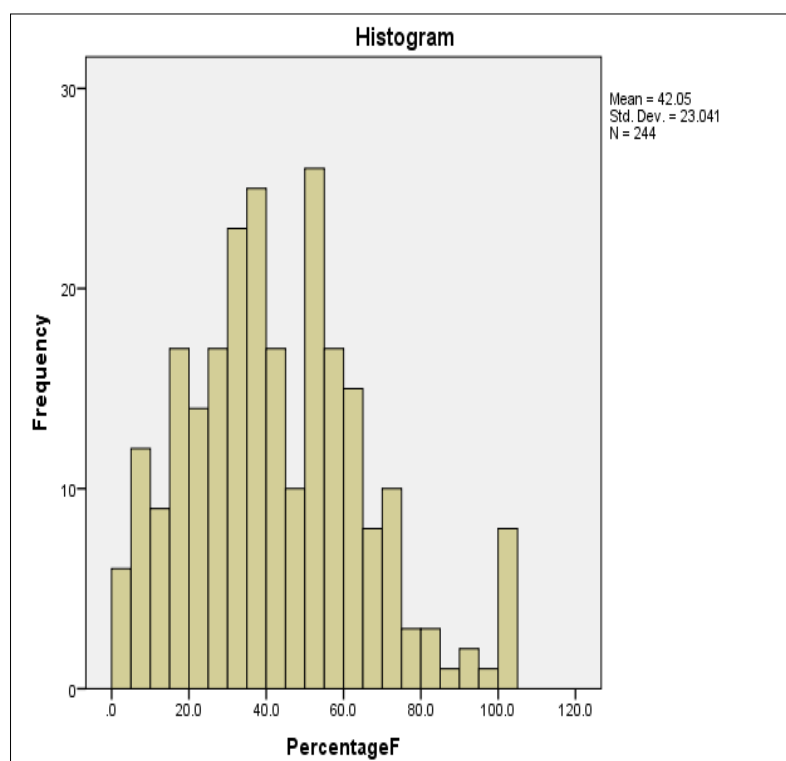


**Figure 2: Percentage female awarded CM from aggregate awarding body data**

<sup>21</sup> There were actually 22 students awarded both CM and A-level in 2018. These have been designated as CM students in all comparative analysis across the three groups in Table 2.

<sup>22</sup> Note that the actual cohort size is difficult to define and is usually of the order of 330,000. Additional complexity is introduced by the fact that CM can be taught over one year or two, and can be studied immediately following GCSE or in subsequent post-16 years.

However, NPD national analysis (Figure 3) shows that the percentage female in each institution entered for Core Maths varies considerably.<sup>23</sup>



**Figure 3: Percentage female in each institution (NPD data 2018)**

We do know from our case study data that different institutions align CM differently with particular subjects, which, in their turn, may manifest a gendered take-up. For example, 75% of Psychology A-level entries in 2018 were female.<sup>24</sup> Institutions where Psychology students are encouraged or obliged to study CM are likely to have a similarly female-dominant CM cohort.

In Table 3, we compare the three groups (Table 2) on female participation rates. The proportion of female students in the 2018 Core Maths group is more equitable compared to that of the A-level Mathematics group, but females are still under-represented in CM compared to the larger group of Level 3 students who have not studied CM or A-level Mathematics.

|                   | Core Maths | A-level Mathematics | Other Level 3 students | Overall |
|-------------------|------------|---------------------|------------------------|---------|
| Percentage female | 42.7       | 39.6                | 53.9                   | 52.0    |

**Table 3: Percentage female across groups of students (NPD data 2018)**

#### 4.1.4 Participation by disadvantage

We focus on two measures of socioeconomic status in the 2018 data. The first is simply called 'Disadvantage', which is a KS4 flag used by the DfE in performance table measures. The second indicates whether a student was eligible for, and in receipt of, free school meals (FSM) at KS4. When comparing the three groups, we again see CM is between A-level Mathematics and Other, on both measures; the Disadvantage measure has higher prevalence than does FSM in all three groups (Table 4):

<sup>23</sup> This figure includes only those centres with entry size at least 10 (n=244), to avoid large peaks at either end of the distribution where entry sizes are very small and one gender predominates.

<sup>24</sup> <https://results.ftteducationdatalab.org.uk/a-level/psychology.php?v=20190822.2>

| Measure                         | Core Maths students | A-level Mathematics students | Other Level 3 students | Overall |
|---------------------------------|---------------------|------------------------------|------------------------|---------|
| Percentage disadvantaged at KS4 | 17.6                | 10.0                         | 23.3                   | 21.6    |
| Percentage FSM at KS4           | 7.9                 | 4.3                          | 11.0                   | 10.1    |

Table 4: Percentage disadvantaged/FSM at KS4 (NPD data 2018)

#### 4.1.5 Number of institutions and entry numbers

Table 5 below gives a summary of how many institutions (formally, these are different centres as defined by awarding bodies) are entering students for CM, and typical entry numbers within institutions over the period 2016 to 2018:

| Measure                        | 2016 | 2017 | 2018 | 2019 <sup>25</sup> |
|--------------------------------|------|------|------|--------------------|
| Number of institutions         | 240  | 440  | 586  | 607                |
| Median entries per institution | 9    | 8    | 9    | 7                  |

Table 5: Institutions and entry numbers (NPD data)

From the most recent NPD data, Figure 4 shows a histogram of the number of entries per institution across the 586 institutions with CM entries in 2018. We see that the distribution is highly positively skewed with only a relatively few institutions having large entry numbers. Similarly skewed distributions are seen in 2016 and 2017.

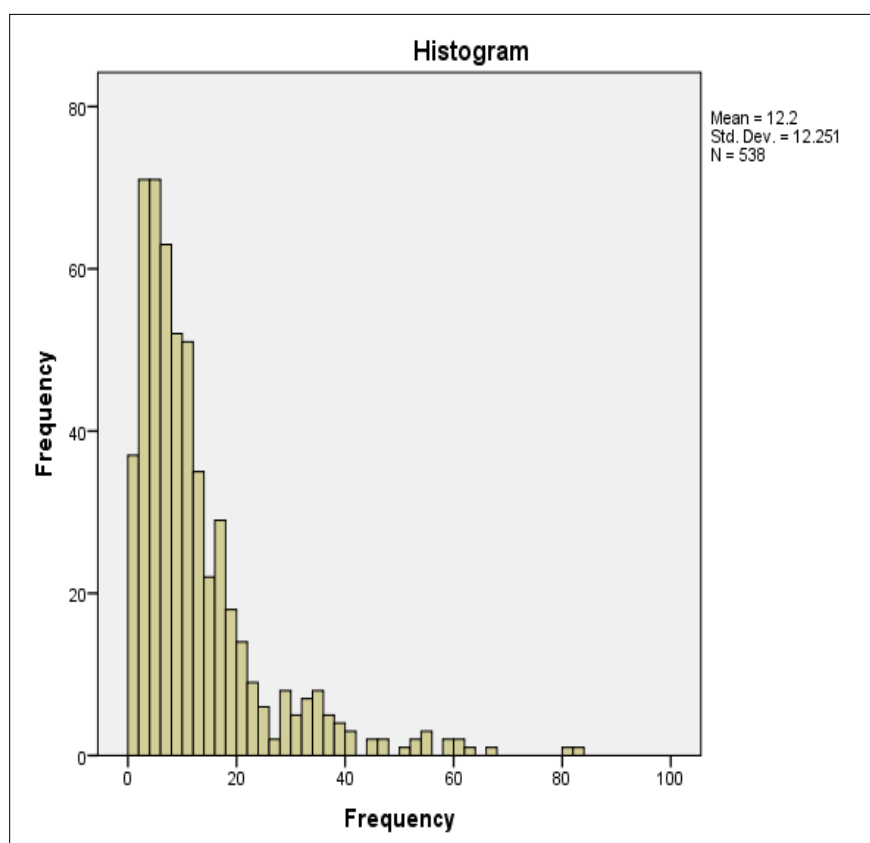
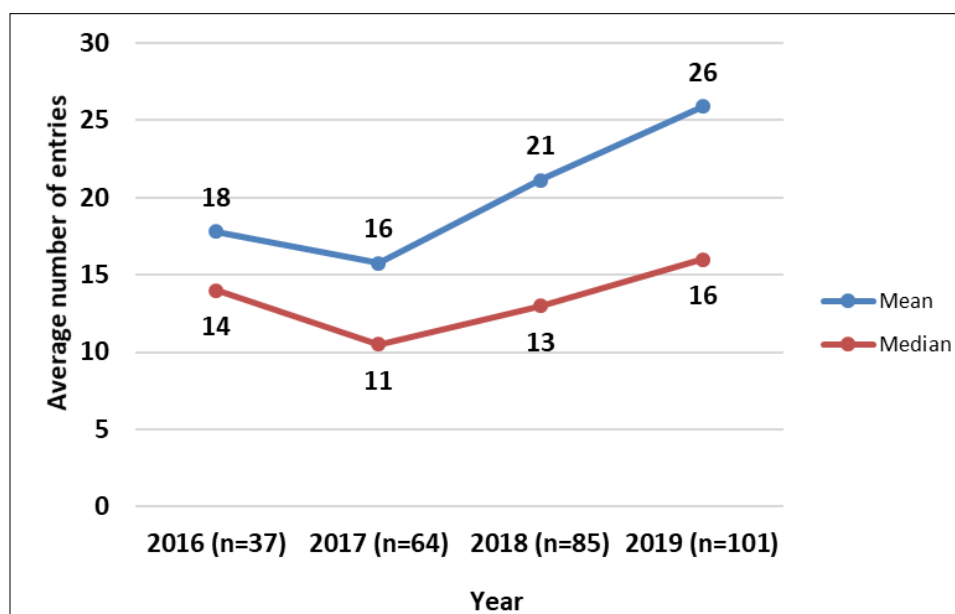


Figure 4: Entry numbers per institution (NPD data 2018)

<sup>25</sup> This latest data comes from the DfE school performance tables 2018-19: <https://www.compare-school-performance.service.gov.uk/download-data>.

In the online survey, we asked about approximate entry numbers for CM within institutions in the period 2016 to 2019. The results are summarised in Figure 5, which shows some growth in entry numbers for this sub-sample of institutions that responded to the survey.



**Figure 5: Typical number of CM entries over time within institution (Online survey)**

The disparity between the national figures and the online survey responses might imply that in the survey we gained responses from institutions which are more successful at implementing CM than is the case nationally.

Behind the overall numbers of institutions providing CM at a particular point in time is hidden a lot of churn in provision. Whilst we have not been able to link separate NPD cohorts to get a detailed sense of this,<sup>26</sup> we obtained, via a Freedom of Information request to the DfE, school/college census data for Core Maths over the period 2014 to 2018.<sup>27</sup> A simple analysis of the data suggests that 22% of institutions (63 out of 286) had dropped Core Maths by 2017-18 having previously taken it up between 2014 and 2016. This suggests that a significant proportion of institutions might be struggling, at least temporarily, to sustain their Core Maths provision.

Our case study data mirror this. Five of our 13 case study institutions did not form a new cohort of CM students in 2018/19. However, one of these five (Rousseau UTC) did resume provision in September 2019.

#### **4.1.6 Variation in entry numbers by institution type and by region**

Within travelling distance of their homes, students usually find that there are a number of post-16 settings, which could include one or more school sixth forms, sixth form colleges, general further education colleges, University Technical Colleges and possibly a studio school. Institutions compete with one another for students, marketing themselves to ensure they are adequately funded in order to remain viable. Decisions they make around their curriculum offer can make the difference between a student enrolling at their institution or not.

In some areas of the country, a combination of 11-16 schools and 16-19 colleges may predominate, meaning that pupils generally transfer from school to college once they have taken their GCSEs. In other areas, 11-18 schools, which have their own sixth forms, compete with local colleges and other schools for post-16 students. In all cases, the links between sixth forms and the lower school, and/or separate partner or feeder schools, are very important, not least in terms of whether students can be recruited in adequate numbers to the Core Maths course.

<sup>26</sup> This is due to recent changes in the way the NPD data are provided - now via the Office for National Statistics' Secure Research Service.

<sup>27</sup> These data are imperfect, in the sense that, at the institution level, numbers of students are suppressed if lower than five, and all other numbers are rounded to the nearest ten.

The splintered nature of the institutional system, where there is competition between institutions for students, can lead to decisions being made on the basis of financial rather than educational considerations. For funding reasons, it is in the institution's interest to attract as many students as it can. Staff in schools and colleges are aware of their budgets and how money translates into teaching capacity. Student numbers in teaching groups, and the feasibility of group sizes, have consequences for Core Maths: small groups are unlikely to be funded.

On the other hand, student grades on their main programme are also important, meaning that institutions do set criteria which students must meet in order to access courses. Reputation in the wider community is dependent on various outcomes, mainly exam results and value-added measures. Centres measure retention and attendance too, and progression from one year to another on two-year programmes. Specific maths performance measures were mentioned infrequently in our case study schools and colleges: only two managers mentioned the Level 3 maths measure, to which Core Maths contributes, saying that this initially persuaded the school to begin offering the qualification.

Students are guided towards particular courses, and particular institutions, including where the best option is to advise them to transfer to another institution for their post-16 education. As one senior manager tells us, it is not sensible for the school to “hang on” to pupils to boost numbers, if later on the students decide to leave or fail their courses. Management attention will be drawn to poor results, even if student numbers are good. The balance between student outcomes and finance are often in tension - between offering students the best or the most appropriate education, and courses being financially sustainable. Managers are performing a constant juggling act between individual students and institutional needs.

It is possible to compare the take-up of CM in different types of institution by looking at national data. Classifying all Key Stage 5 institutions into seven main institution types gives us the following comparison of Core Maths provision (Table 6):

| Institution type                       | CM entries in 2018?               |     | Percentage of institutions with CM entries in 2018 | Percentage of student CM entries in 2018 | Total no. of institutions in 2018 | Percentage of institutions with CM entries in 2016 |
|----------------------------------------|-----------------------------------|-----|----------------------------------------------------|------------------------------------------|-----------------------------------|----------------------------------------------------|
|                                        | No                                | Yes |                                                    |                                          |                                   |                                                    |
| <b>UTC</b>                             | 19                                | 26  | 57.8                                               | 7.2                                      | 45                                | 20.8                                               |
| <b>Sixth Form College<sup>28</sup></b> | 52                                | 28  | 35.0                                               | 10.0                                     | 80                                | 28.6                                               |
| <b>General FE College</b>              | 117                               | 53  | 31.2                                               | 15.5                                     | 170                               | 27.1                                               |
| <b>11-18 School</b>                    | 1,607                             | 380 | 19.1                                               | 63.5                                     | 1,987                             | 6.4                                                |
| <b>Studio School</b>                   | 23                                | 5   | 17.9                                               | 0.6                                      | 28                                | 4.9                                                |
| <b>Independent School<sup>29</sup></b> | 587                               | 24  | 3.9                                                | 2.3                                      | 611                               | NA                                                 |
| <b>Other</b>                           | Figures suppressed for counts < 3 |     |                                                    | 0.9                                      | 41                                | NA                                                 |
| <b>Total</b>                           |                                   |     |                                                    |                                          | <b>2,962</b>                      | <b>2,623</b>                                       |

**Table 6: CM entries by institution type (NPD data 2018)**

Compared to the first entries in 2016 (final column), the proportion of schools tripled by 2018 (from 6.4% to 19.1%) and of UTCs almost tripled (20.8% to 57.8%). Most other institution types have shown more modest growth in CM uptake. In terms of actual student numbers nationally in 2018, 63.5% of CM entries were in schools, 15.5% in FE, and 10.0% in SFCs (NPD, 2018).

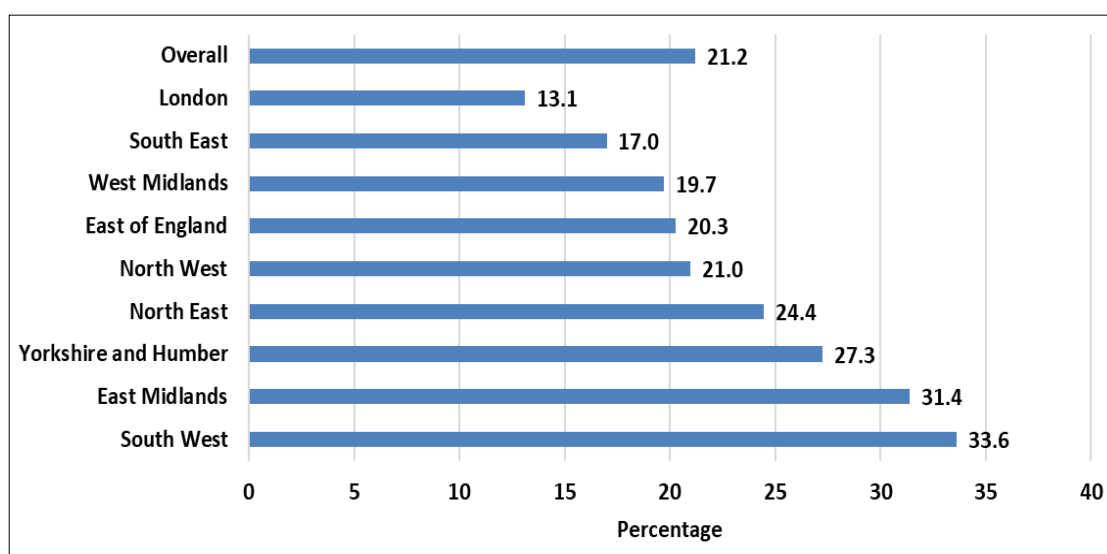
<sup>28</sup> Comparisons of SFC data are difficult over time as there have been a number of closures and mergers nationally in recent years.

<sup>29</sup> Note that figures for independent schools are incomplete as these institutions do not have to submit data by law to the DfE in the same way that state funded institutions do.

In our case studies, we found that school sixth forms often express concern about competition from sixth form colleges and FE colleges. The larger colleges can offer a greater variety of courses to students, and often have newer, attractive facilities. We have seen evidence that CM struggles more to survive in schools than in colleges, mainly because class sizes in school sixth forms tend to be smaller and less sustainable.

Colleges (both FE and SFCs) may have the most scope for growing CM provision in the future, as they have the greatest flexibility of provision. In addition to gathering data from our case studies, we have been able to speak with curriculum managers in further education colleges offering predominantly vocational courses, who are keen to introduce or increase their Core Maths provision. They like the applied and contextual nature of the mathematics involved in CM, and believe it can suit their students well. This greater potential for growth within colleges is backed up by the figures from the Advanced Maths Premium, which we discuss below (see 4.1.7).

National data show evidence of disparity in CM uptake by region. Figure 6 compares regions by percentage of institutions which make CM entries in 2018.



**Figure 6: Percentage of institutions with CM entries by region (NPD data 2018)**

In the 2016 NPD data, the overall percentage was 9.1% and the ordering of regions was quite different (highest 11.9% in North West, and lowest in East of England, 6.6%). This suggests that regional uptake of CM has varied over time and is still evolving, and so it is perhaps too early to make any strong inferences regarding any regional effect on CM uptake.

However, regional differences in terms of percentages of each institution type might be driving some of these differences. For example, in London and the South East there are higher percentages of independent schools (24.8% and 29.4% respectively compared to the national percentage 20.5%), which have not taken up CM as much as schools and colleges in the state sector (see Table 6 above).

#### **4.1.7 The Advanced Mathematics Premium: early data**

Evidence of the shift in take-up by institution and region is suggested by the figures for the Advanced Maths Premium (AMP),<sup>30</sup> as well as through our case study data. The AMP was announced by the Conservative government in the 2017 autumn budget statement. In case study institutions in 2018 and 2019, following this announcement, there was varying awareness of it: some managers were aware, some not; most teachers were not. We did hear the view, within the case studies and from other bodies, that those institutions who had already made the effort to introduce Core Maths into their institutions would lose out unfairly, since they would not be in a position to begin recruiting, or increase their recruitment as much as institutions now given the incentive to recruit. This quote from our online survey shows the scepticism in the sector about how the funding is calculated:

<sup>30</sup> £600 per additional Level 3 mathematics student. Full details here: <https://www.gov.uk/guidance/16-to-19-funding-advanced-maths-premium>.

**I think setting the baseline as the years before most schools & colleges dropped down to 3 A levels being the norm was a sneaky trick meaning the prospect of actual financial payouts is pretty slim.**

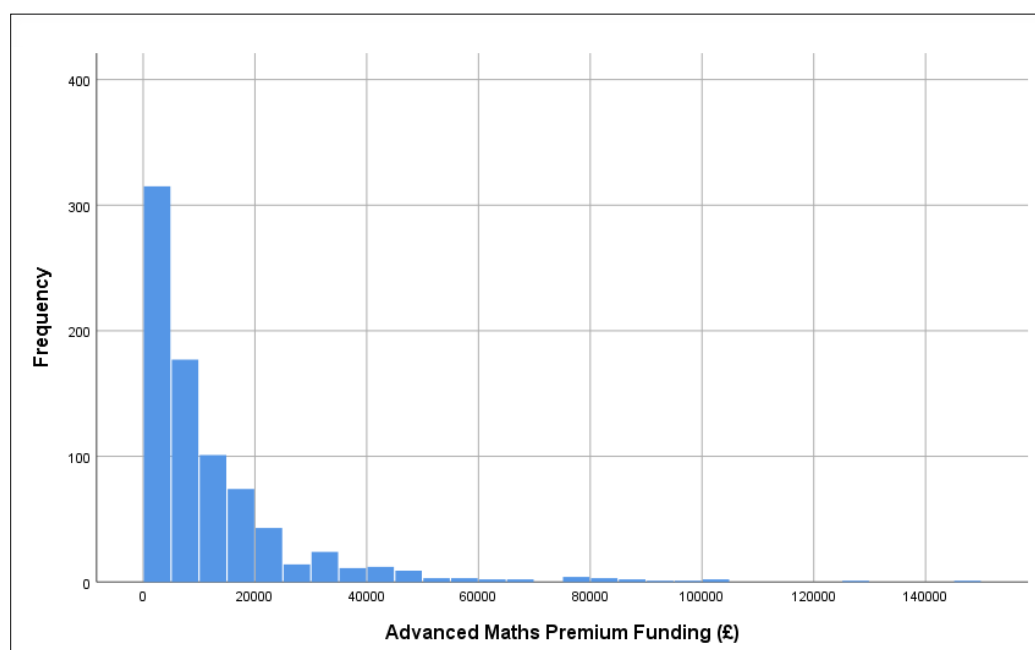
(Head of Maths at a Sixth Form College)

Only two case study institutions were positive about the introduction of the AMP, both larger colleges where the AMP was thought useful for expanding numbers. The other institutions all were of the opinion that the AMP was not an incentive, for two main reasons. Firstly, in schools, there is a small pool to draw on; students interested in doing maths will tend to do A-level, leaving relatively few who wish to take another form of maths. Secondly, over-promotion of Core Maths, aggressive marketing, or obliging students to take Core Maths by linking it to other courses or study programmes, in order to secure the extra funding, can backfire. If students are pressurised to take the course, to increase numbers, there may be a retention problem later on, as Dickenstein SFC found to its cost, when it linked CM with Applied Science, losing more than half its students before the end of the year (2017-18) (see vignette 5.7). Our student data also show that those who have been obliged (they use the word “forced”) to enrol on CM are more likely to express negative comments about it.

The allocation of funding for the first round of the Advanced Mathematics Premium (AMP) is now in the public domain.<sup>31</sup> Data are not disaggregated across the separate mathematics qualifications which attract the premium (e.g. A-level Mathematics, A-level Further Mathematics, A-level Statistics and CM), which means it is not possible to deduce anything specifically related to CM from the data. We focus therefore on what we can deduce overall from the AMP allocation across England.

808 out of 2,836 (28.5%) Level 3 institutions nationally received funding, with a median amount of £7,200, corresponding to twelve additional Level 3 mathematics students. The total funding allocated was £10,630,200, corresponding to 17,717 additional students. This corresponds to 0.19% of the total funding allocated to all such institutions, and to 0.66% of funding allocated to the 808 who benefited from AMP.

The actual distribution of funding is very highly positively skewed, as shown in Figure 7 below, which for presentational reasons excludes three institutions receiving over £150,000 (each of these three received an AMP amount equivalent to over 300 additional students).



**Figure 7: The distribution of AMP funding (2019-2020)**

The correlation between AMP funding received in an institution and other, non-AMP funding received is quite weak ( $r=0.23$ ,  $n=808$ ,  $p<0.001$ ) which suggests that the scale of the institution does not relate strongly to the extent

<sup>31</sup> <https://www.gov.uk/government/publications/16-to-19-allocation-data-2019-to-2020-academic-year>

to which it has been successful in gaining substantial AMP funding. Typically, however, larger institutions, based on funding allocation, do tend to gain more AMP funding than smaller ones. Of the top 30 institutions in the table of funding allocation, 22 are sixth form colleges or further education colleges. This suggests that such post-16 institutions are benefiting more from the introduction of the AMP, while schools are struggling to expand their post-16 mathematics provision despite the AMP. Almost half the institutions awarded AMP money in 2019 had attracted 10 or fewer extra students, across all Level 3 mathematics courses, meaning they may not have attracted enough extra money to fund a separate CM class in those institutions where the break-even number may be in double figures. This is consistent with our case study findings, where schools are the institutions tending to struggle to maintain their Core Maths provision, because of smaller pools from which to recruit. In fact, only one of our thirteen case studies – a large sixth form college – received any AMP funding at all.

There is also some evidence of regional disparity in AMP uptake. Table 7 below shows the percentage of institutions, by region, receiving some AMP. We see that Greater London has the highest percentage (33.4%) whilst the East Midlands has the lowest (20.4%). This regional distribution of funding provides an interesting contrast to the regional uptake of CM in Figure 6 above.

| Region               | Percentage of institutions receiving AMP funding |
|----------------------|--------------------------------------------------|
| Greater London       | 33.4                                             |
| East of England      | 32.3                                             |
| West Midlands        | 30.6                                             |
| Yorkshire and Humber | 28.5                                             |
| South East           | 27.5                                             |
| South West           | 27.1                                             |
| North West           | 26.5                                             |
| North East           | 24.1                                             |
| East Midlands        | 20.4                                             |
| Overall              | 28.5                                             |

**Table 7: Percentage of institutions receiving AMP funding by region**

There is also some regional variation in the typical amount awarded to each institution, as shown below in Table 8.

| Region               | Median value of AMP in institution | Equivalent number of students doing an A-level sized qualification over two years |
|----------------------|------------------------------------|-----------------------------------------------------------------------------------|
| Greater London       | 9,600                              | 16.0                                                                              |
| Yorkshire and Humber | 7,800                              | 13.0                                                                              |
| East of England      | 7,500                              | 12.5                                                                              |
| East Midlands        | 6,600                              | 11.0                                                                              |
| North West           | 6,600                              | 11.0                                                                              |
| South East           | 6,600                              | 11.0                                                                              |
| West Midlands        | 6,000                              | 10.0                                                                              |
| South West           | 5,700                              | 9.5                                                                               |
| North East           | 5,400                              | 9.0                                                                               |
| Overall              | 7,200                              | 12.0                                                                              |

**Table 8: Median value of AMP funding within institution by region**

In the online survey, there were a range of views on the extent to which the AMP would help ensure the success of CM: 54.8% (at least) agreed that it would and 20.3% disagreed. Again, we see variation in response to this issue by institution type, with FE colleges more positive, followed by schools and then by sixth form colleges (66.7%, 55.0% and 45.2% respectively at least agreeing).

**To deliver core maths you need experienced teacher maths specialist and expensing [sic] resources, so the additional funding makes it easier**

(Maths teacher at an FE College)

There is a key interest in the extent to which the AMP might significantly increase the uptake of CM. More quantitative and qualitative research is needed to investigate the impact the AMP funding is having, and how or whether different kinds of institution are able to use it to support and develop their post-16 mathematics provision.

#### **4.1.8 The impact of CM uptake on A-level Mathematics entries**

A-level Mathematics numbers in England declined between 2018 and 2019 by about 5,000 entries, to 85,000 in summer 2019. This represents a 5.8% decline, whilst the cohort was smaller in size by around 2.9%. Over this period, Core Maths entries increased by approximately 2,000 (Figure 1). Whilst there might be some concern that these two changes are directly linked, and that the growth in CM numbers could be at the expense of A-level Mathematics entries, we do not believe this is the case. Based on our research, any relation between the two entry statistics is likely to be quite weak. There are a range of overlapping, and complex, reasons why this is the case, to which we turn briefly here.

The grade boundaries for GCSE Mathematics examinations are now quite low, reflecting the more difficult GCSE assessment (e.g. in the AQA Higher tier in 2019, 57% was required for a Grade 7, and 31% for a Grade 5).<sup>32</sup> Students may therefore be dissuaded from taking up post-16 mathematics courses as a result of more challenging and less satisfactory experiences at GCSE and in the examination, thereby driving numbers down in both Mathematics A-level and Core Maths. Indeed, we know from our case study data that, whilst staff at some institutions say they have not experienced a decrease in numbers taking post-16 mathematics, elsewhere teachers voiced concerns that students' pre-16 maths experiences were leading them to say they would choose to avoid any post-16 mathematics study. At the same time, evidence from our case studies shows that the entry criteria to A-level Mathematics have risen, with Grade 7 at GCSE increasingly becoming the required standard (see Figure 9 for median GCSE grade for A-level Mathematics in 2018), following recent changes to the A-level including a move to synoptic assessment at the end of the two years. For A-level Mathematics, these recent changes are more likely to inhibit than to stimulate participation.

The increased entry requirement for A-level Mathematics could mean that some students who might have previously been able to enrol on it might instead be being guided onto Core Maths, where it is offered. However, students whose original preference is for A-level Mathematics, but who cannot access it due to an insufficiently high GCSE grade, may be more likely to substitute for it a two-year course in another subject, than to choose CM, which does not give them a full A-level-sized qualification. Our data are clear that the overall funding change to per student, not per qualification, means that institutions are moving towards three two-year courses (or an equivalent programme comprising other types of qualification), which is a barrier to the greater expansion of Core Maths.

National data suggest that CM is not usually seen as competing directly with A-level Mathematics (see Table 11 and associated text), but can be a back-up plan when A-level Mathematics does not go well in the first year of post-16 study, giving students a course to transfer to for their second year. This argument is also supported by evidence from our case study data. We note that AS-level data might also, to some extent, now be regarded as historical, given that AS Mathematics numbers have declined dramatically in England, from 150,000 in 2017 to 17,000 in 2019,<sup>33</sup> due to the general decoupling in all subjects of AS from the terminal assessment of A-level. Students' commitment at the outset is now to the full two-year course. Institutions are now less likely to take a risk and allow a weaker student onto

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32 <https://mathsbot.com/gcse/boundaries>

33 <https://results.ffteducationdatalab.org.uk/as-level/mathematics.php?v=20190822.2>

A-level Mathematics, since the opportunity is generally no longer there to be assessed at the halfway point, as was the case with AS, and to cash that AS grade in as an outcome from one year's work. This might mean students transferring to Core Maths from A-level soon after they begin their programme, following some kind of internal assessment; but moving from a 360-hour to a 180-hour course, once options have been chosen and the academic year has begun, clearly leaves the student disadvantaged.

Given the data we have gathered and the arguments above, we believe it highly unlikely that any decline in A-level Mathematics entries is due, in any large measure, to a rise in Core Maths participation.

#### 4.1.9 Section summary: key findings

The introduction of a new and different course which is not A-level Mathematics, designed to allow many more students to study mathematics in their post-16 career, has been broadly welcomed by school and college staff, students, and the wider mathematics education community (4.1.1). CM is well liked and highly valued by teachers and most students who have experience of it.

Growth in the number of students taking CM qualifications has been steady, with uptake rising by around 2,000 per year, from 2,930 in the first cohort (2016) to 11,791 in 2020 (Figure 1). However, the overall number of entries does not currently match the policy aspiration of significantly increasing the number of students studying Level 3 Mathematics, and there remains considerable scope for numbers to increase further.

Core Maths qualifications are approved Level 3 maths qualifications counting towards the Level 3 maths measure. This is a performance measure which the Technical Guide to 16 to 18 Accountability Measures, dated July 2019, states "supports our ambition for the overwhelming majority of young people in England to study maths to age 18 by 2020" (Department for Education, 2019, p.19). This measure has not been adequately used as a lever in driving CM take-up (4.1.6).

Girls comprise a greater percentage of CM students than of A-level Mathematics students (Table 3). Gender balance in CM participation has become more equal over time, shifting from 33.9% female in the 2016 examinations to 45.2% in 2019 (Figure 2). However, the female participation rate varies greatly from institution to institution, and may depend upon how or whether CM is aligned with particular subjects or main programmes (Figure 3).

Survey data suggest that there are varied opinions across England as to the likely impact of the Advanced Maths Premium (AMP) on CM uptake (4.1.7). Schools which have smaller sixth forms may struggle to recruit enough students to create or maintain a CM group, even with the inducement of the AMP. Colleges, with a larger student body, may be best placed to increase their provision.

National data suggest that the overall growth in CM entries also hides a considerable amount of churn, where significant numbers of institutions, particularly schools, have withdrawn or paused their CM provision (4.1.5). Local decisions about its continuation are being made within some institutions on a year-by-year basis (5.14).

There is no evidence to suggest that numbers enrolling on CM courses threaten A-level Mathematics numbers (4.1.8).

## 4.2 Core Maths offers opportunities for Level 3 mathematics study alongside main programme

**An opportunity for students not studying AS or A level mathematics to study a Level 3 mathematics course alongside their main programme of study**

(Core Maths: Technical Guidance)

### 4.2.1 Core Maths “alongside” a main programme of study: positioning

CM was intended for delivery over two years to ensure ongoing mathematics study, alongside students’ 16-18 programme (Department for Education, 2013). CM was designed to support students with mathematical content in other subjects across the whole two-year study period, and keep students studying maths throughout that period even if not taking other numerical or quantitative subjects.

Under the old per-qualification funding model, Core Maths would have naturally formed a fourth option. However, we have been able to capture how the introduction of the new CM qualifications has coincided with the impact of curriculum and funding reforms, as outlined earlier in this report. The financial and structural impact on the post-16 sector of these major changes, and the ramifications for CM, cannot be overstated.

180 GLH are prescribed in total for CM - half the teaching time of an A-level (360 hours) and the same as an AS, though an AS would not usually be taught over two years. Now that the AS is not a standard part of the post-16 structure, Core Maths, the equivalent in size of an AS, is an anomaly. The fourth space, where an additional qualification could be taught, is not directly funded. Management in those centres (e.g. Dickenstein SFC, Jones FEC, Viana SFC) which choose to fund CM as an extra course do so because they believe that the benefits to students outweigh the extra costs to the institution.

As the funding changes outlined earlier indicate, CM is perceived as an awkward fit within the standard study programme of 540 GLHs. Two interlocking factors are at play in the decision-making of institutions about how to manage the implementation of CM: the duration of the course, and the curriculum model, which we now examine in relation to how institutions position (target, brand and promote) CM.

The Early Adopter institutions, which first began teaching Core Maths in 2014, offered Core Maths as a two-year option, with students first sitting examinations in summer 2016. Many Early Developers, beginning in 2015, did likewise. However, institutions discovered that not all students would persist with the course for the full two years. Students left the course after the first year, or left the institution to enter apprenticeships or employment, resulting in a hit to retention statistics. Colleges in particular accept that students may stay at the college for one, two or three years. Decisions were then made to offer Core Maths as a one-year course instead in a number of institutions.

Although the 180 hours for CM are intended to be taught over two years, at 90 hours per year, the total number of hours can be offered, and the course completed in one year, as if it were an AS course. This could be done as in the former 4 + 3 model, as a fourth, one-year, option, but in this option the course is not directly funded. Alternatively, over one year it can be funded as one of three subjects, as any other course would be. However, this leaves a gap in the programme for the second year, as Core Maths, unlike A-levels and BTECs, does not have a natural second year into which to progress. If it were spread over two years, counting CM as one of three options would not work arithmetically at all:  $180 + 180 + 90 = 450$  hours, leaving another 90 to be filled, since a student will not be funded unless they are studying for the full 540 hours in each academic year. This is not a model we found in any of our case study centres or survey.

Thus, the institution must decide whether to offer CM to students as an additional qualification to their three A-levels (or equivalent) for which they are allocated 540 Guided Learning Hours – the model initially envisaged by those who designed Core Maths – or to include it within the student’s GLHs. The decision often ultimately comes down to funding considerations. Each institution has to work out what is the optimum duration for their own context. The table below shows the range of models of implementing the Core Maths course which we came across in our case studies

(Table 9), highlighting the wide variation in approaches taken.

| Length           | Nature of positioning of CM in the wider curriculum                                            |
|------------------|------------------------------------------------------------------------------------------------|
| <b>Two years</b> | Enrichment, alongside three A-levels (or equivalent)                                           |
|                  | Curriculum subject offered in option blocks as 3 <sup>rd</sup> or 4 <sup>th</sup> option       |
|                  | Full course. First year: revision and retake of GCSE Maths. Second year: CM                    |
| <b>One year</b>  | Part of main study programme in Y12. Paired with the EPQ taken in Y13                          |
|                  | Part of main study programme in Y12<br>AS or BTEC modules in as-yet-unspecified subject in Y13 |
|                  | Part of main study programme in Y12 or Y13. Student only banks 2.4 qualifications              |
|                  | Gap-filler in Y13, where student not continuing a course started in Y12                        |
|                  | In addition to main study programme, as fourth curriculum subject, in Y12                      |
|                  | Could be marketed as an enrichment                                                             |

**Table 9: Models of implementation found in our case study centres**

The first two options in Table 9 are those conceivably in accord with the original policy documents suggesting that CM be taught over two years alongside a main study programme (Department for Education, 2013).

Six of our case studies were running a one-year course: three colleges (Arnold FEC, Dickenstein SFC, Mori SFC) and three schools (Bismut, Coates Studio and Lions). Dickenstein, Bismut and Lions had all changed from two-year to one-year courses by the time we visited them in autumn 2017. Evidence of the preference for one year is also shown in our online survey data: 67 of 108 respondents (62.0%) said they were delivering at least some of their Core Maths provision over one year (10.2% of institutions deliver it in one year or two years to different groups). The survey also suggests that FE colleges are mostly delivering CM in a year (90.9%), whereas in schools the corresponding figure is 43.5%. In addition, our Fol data confirms a large shift over time towards the teaching of Core Maths in one year rather than two as originally intended, particularly in colleges.

The arguments for a one-year option go beyond the issue of losing students at the transition between year 1 and year 2. At Arnold FEC, for example, there is a belief that students are not keen to sign up for two more years of maths. The Head of Maths at Lions, and the Core Maths teachers at Dickenstein SFC and Mori SFC, tell us they believe two years would be too long for their students to maintain their interest in CM. We heard a further argument from a number of case studies, which is that of, as the Vice Principal of Coates Studio and the Core Maths teacher at Mori SFC told us, “getting it [Core Maths] out of the way” in the first year, before the pressure of the second year post-16, when students now take their sole and terminal examinations in their main programme subjects.

A one-year maths course makes it possible for students who resit their Maths GCSE in year 1 post-16 to move to Core Maths in their second year. Additionally, institutions are glad to have a one-year course available to students in their second year post-16 who may not be carrying on with one of their other two-year courses, which may or may not be A-level Maths. In this way, the Core Maths course fills what otherwise would be a deficit in a student’s GLHs.

One of the most surprising finds of our study is the extent to which Core Maths is being deliberately offered to students as one of their three main subjects in their study programme, rather than as an extra course running alongside as intended. At Lions, students taking Core Maths as a fourth rather than a third option are only the highest attainers and are in the minority. The Vice Principal at Lions shows it is considered quite normal to include Core Maths within the main study programme, referring to calculating the GLH for students:

*“if there are kids who are low on their guided learning hours, then, obviously that’d be telling us that they’re not taking enough qualifications, so we might encourage them to take that [CM] as one of their qualifications, if it’s appropriate.”*

The normalisation of this approach shows through the expressions of the Assistant Principal at Bismut:

*“We like everybody to start with three courses, whether they are three full courses or not... I wouldn’t, I wouldn’t use the words, ‘we’re not bothered’, but it’d be that guided choice again. If you’ve got a, a weaker-on-entry student or you have a student with, you know, educational needs or, further needs, whatever those needs might be, home life for example, it might be that they just can’t do, four ASes and then, three A2s, um, or whatever the structure of their timetable is so it, it does very much go back to, those sort of guidance conversations and, meeting the needs of, what we have.”*

Including CM as one of three main study programme options in year 1 post-16 does leave a situation where there is no second year into which students can progress, and for funding purposes this gap in study programme has to be filled. The most common way of filling the gap is by enrolling the student on the EPQ in that second year. This combination of CM + EPQ has almost become a third option in itself in some institutions. In our online survey, 12% of institutions report that they pair CM with the EPQ as part of the student’s main programme.

Nevertheless, for other institutions, a two-year Core Maths course does fit well with the two-year linear model towards which the post-16 sector has moved since the decoupling of AS from A-level, and follows the principle of continuing with maths throughout the post-16 phase. Ball and Palis staff both describe how they see their students mature over the two post-16 years, and believe that their students benefit from two years of Core Maths. Ball, Palis and Viana SFC describe how they plan the two-year scheme of work so that the second year has the new, Level 3, content, and possibly the content which supports the more complex aspects of other subjects such as Psychology, which may be taught in the second year of those courses, as well as simply having access to maths during the whole of the two-year period.

Institutions offering Core Maths alongside the student’s main programme may position Core Maths explicitly as what they refer to as an extension or enrichment activity. They may even teach it in a special enrichment period or session on the timetable. In two of our case study schools (Mumford and Donaldson), Core Maths is amongst several enrichment activities from which students can choose, and which are offered in the dedicated enrichment afternoon on Wednesdays. Any student can enrol, no matter what other subjects they are doing. This positioning has the advantage of demonstrating that maths can be for everyone, and that maths can be a cross-curricular interest. It also positions the course specifically as an extra qualification, and as developing a particular skill for life, in the same way as music, sport or drama are seen as enrichment. Healthy uptake of CM is at risk, however, when placing it in direct competition with both the EPQ, also positioned as an extra qualification, and with non-academic activities such as football and film club.

In terms of staffing and funding, running CM over two years demands only half as much teaching time as the one-year course and can be fitted into the timetabling more easily. Centres described to us how some of the time (90 hours per year for two years) for CM was taken from the allotted 60 PEEP hours.

When speaking to students about the length of their course, there were mixed views about whether it was good to have a one-year course and complete it before A-level exams, or whether this made it too rushed with too much content. This often seemed to depend on their teacher’s approach. Some students taking CM over two years said they felt the pace was too slow, reflecting what teachers of one-year courses said would be a potential disadvantage of teaching the course over two years.

In analysing the national data, we note that the NPD only records when qualifications were taken, i.e. the year in which qualifications were awarded, not the date when studying for those qualifications actually began. In order to estimate whether the duration of a Core Maths course for a particular student is one year or two years, we have compared the NPD date of the CM exam award with that of GCSE. We find that the percentage of Core Maths students awarded Core Maths exactly a year on from GCSE is estimated as 42% in 2018 according to NPD data. The corresponding figure from 2016 is 38%, confirming an increase over time in the percentage of institutions teaching CM in one year.

These figures are very likely a considerable underestimate of the actual percentage of students doing CM in a year, since we know from our case studies that there are certainly students completing CM in one year who start the course a year after taking GCSEs, in their second year post-16. Unfortunately, the national analysis cannot identify these students.

An alternative estimate is provided if we calculate the number of students who were awarded only CM in 2018, and nothing else at Level 3 in 2018 or before. There are 2,438 such cases in the data, which is 38.1% of all 6,561 students awarded CM in that year. These then are the students doing CM in Year 12 (or the first year post-16) in a year, and presumably going on the following year (2019) to complete their main programme of study.

The online survey data suggest that, in the majority of institutions (87.0%), at least some students take CM as an extra course, in addition to their main programme. However, in a significant percentage of institutions (19.4%), some CM students take CM as part of their main programme.<sup>34</sup>

#### 4.2.2 Retention problems consequent to being considered an “add-on”

Retention statistics are part of the systematic accountability demands placed on institutions. Problems with retention have been a factor in leading institutions to offer Core Maths as a one-year course, but withdrawals can occur at any point, even during a one-year CM course.

Level 3 qualifications are usually purposed as providing a university entrance route, by virtue of their exchange value, as much as or more than the value of the skills and knowledge developed by the student whilst studying for them during the post-16 phase. Students may discover, once they begin researching HE courses for their UCAS application, that CM does not significantly or directly contribute to the exchange value of a student's post-16 qualification set of three A-level grades or equivalent, or even by being recognised explicitly by the admissions staff for the course and institution to which they are applying (see also 4.8.4), although there is little doubt that CM provides a useful and relevant mathematics course. In withdrawing from the course, they may say they would rather spend that time focusing on their main study programme, which does (in their view) “count”. Core Maths is not their priority.

Teachers and managers alike often refer to CM as an “add-on” to a study programme. Our case study and online survey data show recognition from all sides that CM is usually seen as “an extra” qualification. Teachers, managers and students may speak of a one-year course as being optimal in this context, to “get it over with” in the first year so that it does not interfere with students’ preparation for their main programme in their second year.

Students may see their friends with free periods, or doing another enrichment such as football, when they themselves are studying maths. Staff spoke about the difficulties of persuading students that Core Maths was a course worth taking, even if it was an ‘extra’ to their main study programme. Ball, Arnold FEC and Dickenstein SFC teachers all describe their attempts to explain that students would see maths as valuable if they could appreciate how it would help other subjects. Ball’s Head of Sixth Form says she thinks students do not see how valuable and relevant it is to continue studying maths, and are more short-termist in their outlook. She muses as to whether Core Maths should be run in the second year, once students have matured and perhaps realise that maths would benefit them as they go into HE and/or employment. Dickenstein SFC’s Head of Maths also says she believes that students who enrol on Core Maths, then want to drop it because they discover it ‘won’t count’, are thinking short-term not long-term, valuing free periods with their friends above the benefits of maths in the longer run. Viana SFC’s Head of Maths bemoans the situation vividly:

*“The day-to-day is still an uphill struggle because of student attitude, because they’re lazy, and when they see, they can’t, it’s that deferred gratification, they can’t see the value in what they’re doing now because, actually, it’s only going to be valuable, probably, now when they start to come and do exam prep for, like, Psychology, when they actually start to see these exam questions because they will have not done a lot in lower sixth with them, and only now are starting to see them, and they might go, oh, I understand this a bit more than if I hadn’t done Core Maths. And certainly at the next step, when they go on to post-18, when they go into higher education, if they haven’t, if they are doing anything with quantitative reasoning in it, then I think they’ll realise, they’ll look back and go, oh, this is a good thing that I did that. But they can’t see it forwards.”*

<sup>34</sup> In some institutions, there are different implementations of CM, hence the figures add to more than 100%.

One of the CM teachers at Dickenstein SFC makes an important statement about how the students who do take and complete the course demonstrably enjoy it and are glad that they have stuck with it, which motivates her in her work. Yet she is worried that senior management will not allow it to continue running because of the retention problems resulting from students dropping the course. The staff at Dickenstein SFC have made considerable efforts to dissuade or even prevent students from dropping CM. They even speak about trying to integrate CM into a main programme, including creatively timetabling it between lessons in their triple BTEC programme in an attempt to maximise attendance. Ultimately, the logistical problems and questionable ethics of these ideas have meant they have not been attempted, and retention issues remain.

We have observed that, amongst our case studies, at least, retention on CM courses is not necessarily such a problem in further education colleges. This could be because study programmes are considered more holistically by students and staff than they seem to be in schools and SFCs. Core Maths, like the GCSE resits which so many FE students have to include in their timetables, seems to be marketed and accepted as integrated within the study programme, rather than as an extra course. Students may not see their post-16 education in quite the same way as the accomplishment of three separate qualifications which lead to higher education. Core Maths is marketed and seen, not necessarily as a separate qualification or for UCAS points, but for the maths skills to be honed and developed through the course, which will help support other subjects, and also be useful in the future.

Online survey data indicate that where students withdraw from CM, the most commonly cited reasons, as reported by our respondents, were to concentrate on their main programme (82% of respondents saying this happened at least sometimes), and having too much work when CM is studied alongside the main programme (80% reporting this happened at least sometimes). However, the overall feeling in the survey data is that retention in CM has been 'good' (58.5% at least agreeing with this statement).

### 4.2.3 Reasons for not offering Core Maths

National data show that approximately four out of five schools and colleges had no CM entries in 2018 (see Table 6). There are many schools and colleges where a decision has been taken not to offer Core Maths at all. The problem is not necessarily related to the course content or the approach it takes to the application of maths. As Dickenstein SFC's Head of Maths says:

*"The negatives aren't to do with the qualification."*

Data gathered from such institutions, whether from Heads of Maths or from maths teachers, centre around the fact that CM is essentially half a course, with 180 hours' teaching time over two years, when all other courses have moved to a two-year 360-hours linear form, and funding per student is for three 360-hour two-year courses. CM offers no progression into a second year, if offered as a full-time course in year 1, or can leave the student with only two-and-a-half qualifications instead of three. Where offered over two years, it has to be extra to a three-course main programme, which brings with it different challenges.

There is particular incomprehension and frustration in the institutions where Use of Maths was previously taught successfully. Use of Maths, which became a full A-level but only as a pilot, with restrictions on the numbers of students who could ever take it, was popular as an alternative to A-level Maths, since a grade from Use of Maths would count as one of the three grades on which an HEI would make an offer. One sixth form college Head of Maths expressed himself strongly to us on this topic:

*"the government [have been] complaining there's a lack of uptake at Level 3, qualifications in maths, and then they've, and they've completely, shot themselves in the foot by replacing the one that was fantastic, and replacing it by something, which, you know, there's no progression... it's always gonna be an add-on, and the thing is, the key thing about the students, they wanna get three really good A-levels, to get to university, and it just doesn't fit in anywhere. I, I honestly I think Core Maths is an absolute shocking qualification, and it replaces something that was fantastic. And I just think there's a complete lack of joined up thinking from the government."*

One of Dickenstein SFC's CM teachers says she would prefer to offer Use of Maths than Core Maths, because it is a full A-level, even though she very much likes the variety of topics and the approach of Core Maths, which is even more realistic than Use of Maths was. She recalls how the options within Use of Maths complemented other subjects, as do the options within CM. Our data show that there are colleges who have elected to offer A-level Statistics rather than CM simply because it is a full A-level. Teachers, managers and students alike are of the opinion that more students would take CM if it was equivalent to a full A-level.

#### 4.2.4 Core Maths alongside main programme subjects

Turning to another facet of the purposes of Core Maths, and another meaning of 'alongside', one of the main objectives, according to government documentation (DfE, 2014), is to support the mathematical or quantitative aspects of other curriculum subjects, such as Psychology, Biology, Business, and Geography, as students progress into HE or employment related to these disciplines. It is important to consider whether Core Maths is seen or felt to be supporting the continued study of these other subjects.

Teachers, managers and students across our case study institutions tell us that they believe CM will support other curriculum subjects, reflecting statements about the benefits of CM in policy and other documentation. Some of the case studies align CM with particular subjects or pathways. Jones FEC and Coates Studio offer the TechBacc<sup>35</sup> with a focus on IT/Scripting and Programming. Dickenstein SFC strongly advises Applied Science students to take CM. At Viana SFC, the policy is that, in order to do particular A-levels (e.g. Psychology), students must have a grade 5 in GCSE Maths, or enrol on CM.

Students report, at the start of their CM course, that CM has been recommended to them, or they have explicitly chosen CM, because it will support their Business Studies, Geography, Psychology or other:

*"So, they're [Biology, Chemistry and Psychology] obviously, quite maths-based, so, and I don't want to do A-level Maths, so I thought that this would help me develop my maths for those other subjects"*

(Mumford student)

Mori SFC's Geography teacher says she was very pleased that some of her students were doing Core Maths, since they were able to practise statistics and graph skills, giving them confidence. She says confidence is "the main thing". The CM teachers at Mumford relate how their students find practical connections between CM and other subjects; students tell us about links with their other subjects, and the opportunity they have, in CM lessons, to go into more depth with the maths than they can do in their other subject lessons.

When we revisited the case studies in the summer terms of 2018 and 2019, students who had completed the course were generally positive about CM supporting their other subjects. One student claimed that doing CM alongside Economics, when many others in the class were doing A-level Maths, had helped her "keep on a level with [maths]". Students felt that CM supported them in a range of subjects, in fact, including Business, due to learning about interest rates, tax calculations and so on. The links between CM and Applied Science were mentioned in several case studies, and it was interesting to hear from students taking CM in the second year of Applied Science that the science was feeding into CM in its turn.

There was some, but relatively little, dissatisfaction in student interview data about lack of crossover with some specific A-level subjects, e.g. A-level Biology, as students seem to have had their expectations raised by what their teachers have told them. However, from the teachers' point of view, we learned that simply keeping maths skills alive is important and helpful, even if students feel that particular skills or content knowledge do not transfer directly between CM and other curriculum subjects.

Students who had been, as they describe it, "forced" to enrol on CM were more likely to make less positive comments than students who had more choice in taking it, including being more likely to say they could not see the link between

<sup>35</sup> The Technical Baccalaureate, a performance measure at Level 3 which includes three technical qualifications, a maths qualification, and the EPQ.

CM and their related subject. Some students resented being obliged to take maths because, they said, in school they had been told that if they got a grade 4 in GCSE they would not have to do mathematics again. It seems as if several of the students who had to take CM had had poor experiences of maths in school which had clouded their view of the subject.

Maths teachers across the case studies actively promote CM as helping with subjects students may wish to pursue at university. Despite this perceived link, Heads of Department with oversight of maths and other subjects, and teachers and Heads of Maths, are unsure how aware staff beyond the maths department are of Core Maths, or of its nature and benefits to learners, even in institutions which introduced Core Maths at least in part to support other subjects. Non-maths staff are thought unlikely, in those circumstances, to promote it or encourage students to study it. However, the Geography teacher at Mori SFC highlights that the responsibility for promotion of Core Maths should not be carried by just one person, or by just the maths department: in her opinion, the staff as a whole should be supportive of Core Maths.

Viana SFC's Head of Maths described some other departments as "very keen on it" and some as "agnostic, I guess", illustrating how the promotion of a new course can depend on the attitude of certain individuals, some of whom may display scepticism. At Mumford, one of the Core Maths teachers observes that non-maths staff will not generally be aware of what happens in maths in general, so they are unlikely to be concerned with what happens in Core Maths, believing that it is a continuation of maths, rather than potential support for their own subject area.

The business of increasing awareness about CM amongst non-maths staff depends on communication between particular groups. Proximity is important: where face-to-face contact naturally occurs, via shared workrooms or corridors where certain departments are spatially closely located, it becomes easier to talk about CM. Teachers may find that physical divisions in the school often act as barriers to having fruitful discussions with other staff, and encourage their students to speak to their other subject teachers. As one of Mumford's CM teachers explains:

*"as you know, it's a big school so the, generally the departments stay in their own work space areas, um, and, don't really see other, other teachers. You see them from time to time in the staff room but not, other, like meetings and such like that."*

This contrasts with Rousseau, a relatively small school with one large, central staff workroom. The Principal and Head of Maths at Rousseau believe that this physical arrangement and the ease of face-to-face communication between staff has facilitated the spread of awareness about CM.

Over time, data show staff in other curriculum areas becoming more aware. The spread of knowledge has occurred because of students talking to their other subject teachers about Core Maths, and also because of Core Maths teachers themselves spreading the word to their non-maths colleagues, partly through attempts at recruitment at each new enrolment period, and partly through conversations about the content of subject specifications, as Core Maths teachers were proactively finding out how their Core Maths content and approach might reflect and support that of the other subjects.

### 4.2.5 What are Core Maths students also studying? National data

We have examined the national data to see what subject qualifications are being awarded to Core Maths students, and also to see if there is any evidence to suggest that studying CM has any impact on student outcomes in those other subjects.

Analysis of all three cohorts indicates that Core Maths students have been studying a very wide range of other subjects and qualifications, but that there has been a move away from BTECs and towards A-levels over time. Table 10 below shows the list of the most popular BTECs and A-levels awarded to the very first (2016) CM cohort, according to NPD data. In some cases (24%), the student has been awarded the qualification in an earlier year.

| Qualification                            | Subject                              | N   | Percentage of CM cohort (n=2,738) |
|------------------------------------------|--------------------------------------|-----|-----------------------------------|
| <b>BTEC Diploma Level 3<sup>36</sup></b> | Engineering Studies                  | 239 | 8.7                               |
| <b>BTEC Diploma Level 3</b>              | Applied Sciences                     | 233 | 8.5                               |
| <b>BTEC Diploma Level 3</b>              | Computer Appreciation / Introduction | 213 | 7.8                               |
| <b>A-level</b>                           | Psychology                           | 207 | 7.6                               |
| <b>BTEC Diploma Level 3</b>              | Business Studies                     | 162 | 5.9                               |
| <b>A-level</b>                           | Biology                              | 161 | 5.9                               |
| <b>A-level</b>                           | History                              | 143 | 5.2                               |
| <b>A-level</b>                           | Geography                            | 137 | 5.0                               |

**Table 10: Qualifications awarded to CM students in 2016 (entries over 100)**

Table 11 below shows the equivalent data for the 2018 CM cohort. As in the first cohort, there is a diverse and long list, but for this cohort it is dominated by A-level qualifications.

| Qualification                         | Subject                        | Frequency | Percentage of CM cohort (n=6,561) |
|---------------------------------------|--------------------------------|-----------|-----------------------------------|
| <b>AS-level</b>                       | Mathematics                    | 685       | 10.4                              |
| <b>A-level</b>                        | Psychology                     | 649       | 9.9                               |
| <b>Extended Project Qualification</b> | Study Skills (EPQ)             | 629       | 9.6                               |
| <b>AS-level</b>                       | Psychology                     | 604       | 9.2                               |
| <b>A-level</b>                        | Biology                        | 589       | 9.0                               |
| <b>AS-level</b>                       | Biology                        | 576       | 8.8                               |
| <b>A-level</b>                        | Business Studies               | 483       | 7.4                               |
| <b>A-level</b>                        | Geography                      | 414       | 6.3                               |
| <b>AS-level</b>                       | Business Studies               | 398       | 6.1                               |
| <b>AS-level</b>                       | Chemistry                      | 397       | 6.1                               |
| <b>A-level</b>                        | Chemistry                      | 346       | 5.3                               |
| <b>AS-level</b>                       | Geography                      | 302       | 4.6                               |
| <b>VRQ level 3</b>                    | Finance / Accounting (General) | 282       | 4.3                               |
| <b>A-level</b>                        | History                        | 276       | 4.2                               |
| <b>AS-level</b>                       | D&T Product Design             | 274       | 4.2                               |
| <b>AS-level</b>                       | Physics                        | 262       | 4.0                               |

**Table 11: Qualifications awarded to 2018 CM students (entries over 250)**

<sup>36</sup> Note that these can be equivalent in 'size' to between 0.5 and 3 A-levels – but are mostly the latter.

Some interesting observations can be made about these combinations. First, AS-level Mathematics is the most popular subject awarded with Core Maths, being awarded to over 10% of the 2018 CM cohort. The majority, 536 out of the 685, were entered for AS Mathematics in 2017, and, of them, 81% were awarded a U grade and 15% an E. This reflects our case study data, which show that CM is being used as a progression route following a poor AS-level Mathematics performance.

The EPQ is third on the list but, in contrast to AS-level Mathematics, most of the EPQ qualifications are awarded in 2018 (459=73%, with 163=26% in 2017), i.e. at the same time as CM was awarded. This suggests that 7% of CM students are studying it in parallel with the EPQ. Our case study data would point to a need for these students to accrue the UCAS points from both qualifications in order to access HE, having dropped a two-year qualification after only one year.

For those with both EPQ and CM, the most popular other subjects awarded were AS-level Mathematics, A-level Psychology and A-level Biology. In other words, there is little apparent difference in the qualification mix of the EPQ-and-CM group compared to the larger CM group who did not have the EPQ.

Focusing only on those qualifications awarded in 2018, the data in Table 12 show the following:

| Qualification                  | Subject                        | Frequency | Percentage of CM cohort (n=6,561) |
|--------------------------------|--------------------------------|-----------|-----------------------------------|
| A-level                        | Psychology                     | 637       | 9.7                               |
| A-level                        | Biology                        | 582       | 8.9                               |
| A-level                        | Business Studies               | 474       | 7.2                               |
| Extended Project Qualification | Study Skills                   | 459       | 7.0                               |
| A-level                        | Geography                      | 408       | 6.2                               |
| A-level                        | Chemistry                      | 345       | 5.3                               |
| AS-level                       | Psychology                     | 286       | 4.4                               |
| A-level                        | History                        | 275       | 4.2                               |
| A-level                        | Economics                      | 246       | 3.7                               |
| A-level                        | Sociology                      | 241       | 3.7                               |
| AS-level                       | Biology                        | 231       | 3.5                               |
| A-level                        | English Literature             | 208       | 3.2                               |
| VRQ Level 3                    | Finance / Accounting (General) | 204       | 3.1                               |

**Table 12: Qualifications awarded only in 2018 to 2018 CM students (entries over 200)**

Of these qualifications, A-levels in Psychology, Biology, and Business Studies have the largest entry numbers, but these are still quite a small proportion of the CM cohort (<10%). Geography and Chemistry also have quite large numbers. Our analysis in the next sub-section uses these five A-levels to investigate whether there is any evidence that studying CM alongside these subjects enhances attainment (see 4.2.6). The first non-AS or A-level in Table 12 is VRQ Level 3 Finance/Accounting, which is approximately AS-level in size.<sup>37</sup>

Comparing 2016 and 2018, we see that the proportion of BTECs qualifications taken alongside Core Maths has decreased over this time (Table 10 and Table 12). The most popular BTEC amongst CM students in 2018 is the National Extended Certificate at Level 3 in Business Studies, with 113 entries in 2018 (2% of the CM cohort).

<sup>37</sup> This is the Pearson London Chamber of Commerce and Industry Level 3 Certificate in Financial Accounting - see <https://qips.ucas.com/qip/pearson-lcci-level-3-certificates-accounting-and-finance-vrq>.

### 4.2.6 Impact on attainment in other subjects

As we have reported, a widespread perception emerges from our survey and qualitative data that studying CM will support a range of other subjects. In fact, AQA states explicitly on its website that Core Maths qualifications help develop students' mathematical skills and thinking, and support A-level courses like Psychology and Geography, as well as technical and vocational qualifications.<sup>38</sup> In fact, technical and policy documentation (e.g. Department for Education, 2013) states as one of the purposes of CM that it supports further study, rather than study contemporaneous with the CM course itself, a fine but perhaps salient distinction.

In our online survey, when asked why their institutions were offering CM, the most popular response from respondents was that it supports other Level 3 science subjects (76.9% respondents reporting this). The second most popular response was that it supports other Level 3 (non-science) subjects (68.5%).

In this sub-section, we investigate the extent to which there is any evidence in the 2018 NPD data that students studying CM have higher attainment in the five most popular A-level qualifications that CM students were awarded in 2018, which, as we saw above, were Psychology, Biology, Business Studies, Geography and Chemistry. We start with a raw comparison of attainment, e.g. comparing Psychology attainment between those who had also studied CM and those who had not, and then carry out a statistical modelling exercise comparing the same two groups but this time controlling for a range of additional factors (e.g. prior attainment, gender, socio-economic status, institution type).<sup>39</sup>

The sample sizes for the five comparative analyses are shown here in Table 13.

| A-level subject         | Had a CM maths qualification |     |           | Total  |
|-------------------------|------------------------------|-----|-----------|--------|
|                         | No                           | Yes | % with CM |        |
| <b>Psychology</b>       | 43,844                       | 936 | 2.1%      | 44,780 |
| <b>Biology</b>          | 25,591                       | 800 | 3.0%      | 26,391 |
| <b>Business Studies</b> | 20,760                       | 632 | 3.0%      | 21,392 |
| <b>Geography</b>        | 20,869                       | 551 | 2.6%      | 21,420 |
| <b>Chemistry</b>        | 12,212                       | 446 | 3.5%      | 12,658 |

**Table 13: Sample sizes for attainment comparison (NPD 2018)**

When we compare raw attainment between the two groups at A-level, we typically see that the CM group have lower performance. Figure 8 gives mean attainment scores (and 95% confidence intervals for this mean) between the two groups ( $A^*=60$ ,  $A=50$ ,  $B=40$ ,  $C=30$ ,  $D=20$ ,  $E=10$ ,  $U$  and  $X=0$  using the NPD scoring system), and shows that CM students have slightly lower mean attainment in all subjects, by around 5% of a grade in Psychology to 23% of a grade in Chemistry. These differences are all statistically significant at the 5% level except for that in Psychology. In other words, in terms of raw attainment, the CM group are lower attaining in each of these A-level subjects compared to their non-CM peers, with the exception of Psychology.

<sup>38</sup> <https://www.aqa.org.uk/subjects/mathematics/aqa-certificate/mathematical-studies-1350>

<sup>39</sup> We have removed from this analysis any students who have also been awarded AS and A-levels in mathematical subjects (e.g. Mathematics, Further Mathematics, Statistics).

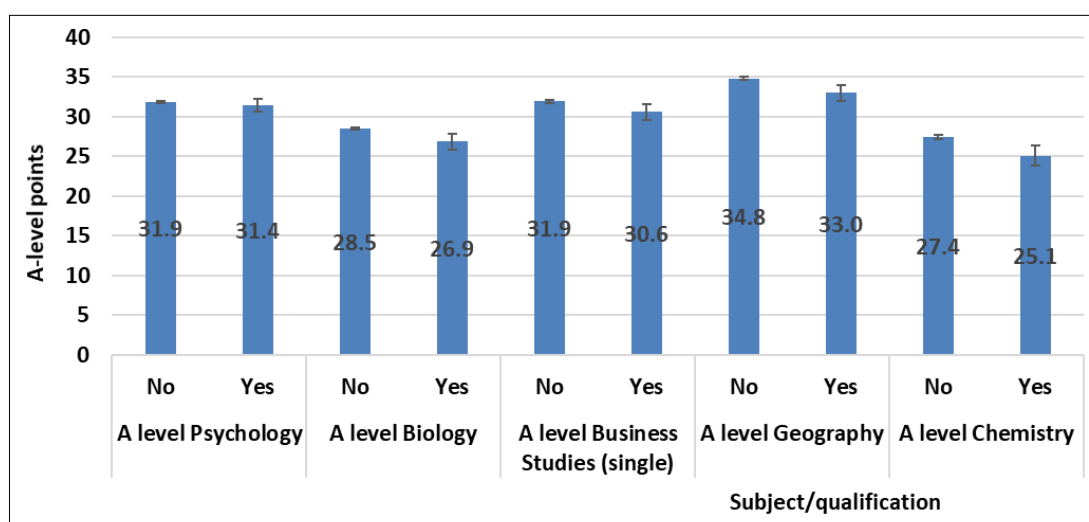


Figure 8: Mean raw attainment (CM – Yes/No) (NPD 2018)

In Table 14 below, we summarise the results of five multi-level models comparing attainment, whilst controlling for prior attainment in GCSE English and Mathematics, gender, three measures of socio-economic status (FSM and ‘Disadvantaged’ at the student level, and ‘Disadvantaged’ aggregated to the institution level) and institution type.<sup>40</sup> Our key predictor of interest is whether or not students had also studied CM (1=Yes, 0=No).

| Subject          | CM estimate |            |                                    |       | Std. Error | df    | t     | Sig. |
|------------------|-------------|------------|------------------------------------|-------|------------|-------|-------|------|
|                  | Points      | % of grade | 95% confidence interval for points |       |            |       |       |      |
| Psychology       | 0.17        | 1.7        | -0.64                              | 0.99  | 0.42       | 35197 | -0.42 | 0.68 |
| Biology          | 0.37        | 3.7        | -0.58                              | 1.31  | 0.48       | 16369 | -0.76 | 0.45 |
| Business Studies | -1.28       | -12.8      | -2.27                              | -0.29 | 0.50       | 15605 | 2.54  | 0.01 |
| Geography        | -0.46       | -4.6       | -1.46                              | 0.55  | 0.51       | 14821 | 0.89  | 0.37 |
| Chemistry        | -0.04       | -0.4       | -1.38                              | 1.30  | 0.68       | 7724  | 0.06  | 0.95 |

Table 14: CM coefficient in multi-level model comparing A-level attainment (NPD 2018)

All the estimates of the CM effect on attainment are quite small (at most, 13% of a grade). The only statistically significant coefficient is for Business Studies, which indicates that Business Studies students also taking CM are, according to this model, scoring on average around 13% of a grade lower than those not taking CM, having controlled for the other factors in the model. It is important to acknowledge that this analysis is quite limited, and problematic for a number of reasons. There could be other factors that we have not been able to include here, for example, more fine-grained measures of socio-economic status, student ethnicity, additional school/college factors, and more comprehensive measures of prior attainment and so on.

The variables we have included are not perfect measures. For example, the prior attainment scores have (measurement) error in them; GCSE grades are not 100% reliable and are quite granular. In addition, there remains a missing data problem: a percentage (~10%) of the predictors in these models had missing data, which might have introduced further bias to the CM estimates. It is also important to recognise that only a relatively small proportion of the summative assessment in each of the five subjects listed is explicitly mathematical in nature, and so it might be unrealistic to expect to find a clear CM effect in examination grades. Finally, case study and survey data suggest that CM implementation is very varied across England, and that CM is aligned (or not) in very different ways with main study

<sup>40</sup> We have avoided using other predictors, e.g. IDACI and ethnicity, as there was considerable missing data in these (either as measured at KS5 or at KS4), partly by design, since the annual KS5 census does not take place in FE or sixth form colleges in the same way as it does for schools.

programmes and subjects. The modelling we have carried out produces an averaged national CM effect, which obviously misses the nuance of what might be happening in particular institutions.

Despite all these caveats, it seems likely that whether or not a student has studied CM alongside this set of A-level subjects makes little or no difference at the national level to attainment in these qualifications. Similar results were found in the 2016 data (Homer et al., 2017).

Our final comment here is that, of course, although there is no evidence of direct aggregate benefit when comparing grades, this analysis does not rule out the possibility that studying CM has supported the study of these subjects in a range of other ways that are not captured in the final examination(s). For example, a useful interview with a Geography teacher at Mori SFC gave us an insight into the aspects of Core Maths which she felt were especially beneficial. The teacher, referring to students' maths skills, used the phrase "use it or lose it": she was pleased that her Geography students had the opportunity to practise statistics and graph skills within the Core Maths course. In particular, she believed that it had given her students confidence, which is "the main thing".

#### 4.2.7 Section summary: key findings

The original two-year design of the CM course lends itself well to being offered to students who wish to maintain a breadth of study in their post-16 programme, who are comfortable with the extra work this entails, and who value the usefulness of the extra skills and confidence they develop in maths, whatever other subjects they are studying (4.2.1). However, a two-year course does not necessarily suit students who are less committed to mathematics as an extra course beyond their main programme, and this can cause a retention problem, with students withdrawing from the course (4.2.2).

A range of data suggests that there has been a widespread shift towards teaching CM over one year (4.2.1). Reasons for this include avoiding dropout between year 1 and year 2, moving CM examinations away from main programme examinations at the end of two years, and providing a one-year option for students who would otherwise have a gap in their study programme after withdrawing from a two-year course at the end of only one year.

Systemic issues are likely to continue militating against substantial growth of CM, no matter how positively students and teachers have received the course itself (4.2). The post-16 funding structure which supports three A-levels or the equivalent can leave little room for manoeuvre for offering extra courses. The AS-like size of CM does not fit comfortably into the new linear post-16 landscape. As a result, we have seen a range of models of implementation (Table 9), as each school or college has to work out how best to manage implementation within its own constraints and according to its needs and priorities. Some institutions choose not to engage at all with the complexities of deciding how to deliver CM, and therefore do not offer it.

Awareness of CM is not necessarily strong beyond the maths department, including in institutions where CM is being taught, meaning that non-maths staff are not well enough informed to advise students about the benefits of taking CM (4.2.4).

Students and staff perceive that studying CM supports other subjects with a mathematical or quantitative element such as Psychology, Biology and Business Studies (4.2.4). This may be related more to the confidence and the facility with applications of mathematics which are developed, than to the specific content of a particular subject or CM specification. There is no compelling evidence from national data to suggest that studying CM enhances examination outcomes in other (A-level) subjects (4.2.6).

There has been an apparent shift in the most popular qualifications which CM students are also studying (4.2.5). In 2016, CM students were predominantly also studying BTEC qualifications; by 2018, the most popular companion qualifications are A-levels. A significant minority of students are pairing CM with EPQ to make up what is essentially a two-year course (4.2.1). Because CM and EPQ are unequal in terms of UCAS tariff, this combination does not quite offer the equivalent exchange value of a full two-year course.

## 4.3 Core Maths is a qualification for those with GCSE Maths grade 4 and above

**‘Core Maths’ is a performance table category which signifies mathematical qualifications suitable for those with a grade 4 or above**

(Core Maths: Technical Guidance)

In an ideal world, an institution might decide to offer Core Maths because it would benefit particular, or all, students, and then timetable it within their provision with a view to enabling those target students to access the course. In reality, due to the operational issues discussed above around how to fit delivery of the course into an existing system which militates against it, the process may occur the other way round. Schools and colleges work out how to manage the delivery of the course, and then decide which students they can target. In some cases, for example where Core Maths is positioned as an enrichment, any student can, theoretically, access it, but the competition for student attention will rule out students who are not motivated to choose maths above other, often extra-curricular, activities, including sports. It could be said that this is selection and exclusion by the back door. A genuine desire for all students to access Core Maths, it could be argued, would place the course in several option blocks, giving it the same status as other curriculum subjects. Ball High School tried positioning CM as the equivalent of any other post-16 course, to little effect: students realised that it is only the equivalent of an AS.

To access Core Maths, according to the qualification guidance (Department for Education, 2013), students need to have attained at least grade 4 (formerly grade C) in GCSE Maths. Some case study institutions (e.g. Donaldson) set their access grade at 5, because, staff tell us, in their experience, students with grade 4 will find the course too challenging. In other centres (e.g. Viana SFC), where CM is seen specifically as a support course for the mathematical content of other subjects they wish to take, it is students with a grade 4 who are identified and targeted with Core Maths.

Within the case studies, we came across the perception that, in general, students who like and are good at maths will take Maths A-level, and that other students, who do not see the relevance of maths, avoid the subject and are nervous about it. In two of our case studies, Mori SFC and Donaldson, one and two students respectively, who enjoyed maths and were good at it, were taking both A-level Maths and Core Maths, because they wanted to do as much maths as possible. These students are very much in the minority.

Viana SFC’s Head of Maths tells us that “Those students”, i.e. those who do not wish to take A-level Maths but do wish to continue with some maths, “don’t exist”. He and the senior management conclude that the only viable way to offer Core Maths is to direct particular students onto it in a systematic way. Over time, they move from a policy of students opting into Core Maths, to enrolling students onto CM as a support course. By contrast, the Head of Sixth Form at Ball is unwilling to embrace a policy which would force certain students to take Core Maths. Students, in her view, should be given a free choice. The numbers opting in, however, are in the ones and twos, and the course is dropped.

Our case study data suggest that Core Maths students fall into four broad groups:

- Students who would like to, but cannot, access A-level Maths;
- Students who do not wish to take A-level Maths but want to continue with some maths;
- Students directed to take Core Maths, either as part of a pathway or programme, or because they do not have the required Maths GCSE grade to access other subjects;
- Students who need a one-year option to fill up their programme, particularly in the second year post-16.

These groups will be discussed in turn.

### ***4.3.1 Students who would like to, but cannot, access A-level Maths***

Students may enter the sixth form wanting to study maths, and with an intention to enrol on A-level Maths. Their GCSE grade, or an assessment task given at enrolment, or four weeks or so into the autumn term for those beginning the A-level course, may determine whether the student can stay on the A-level or whether they are advised to move, or are moved, into Core Maths. This route to Core Maths as “an alternative to A-level Maths” is described variously by teachers and managers in our case studies as the “default” (Head of Department, Mori SFC), the “safety net” (Principal, Dickenstein SFC), the “consolation prize” (Head of Maths, Palis). Students (e.g. at Lions) describe themselves as “defaulting” onto Core Maths through not being able to access the A-level.

This group may find themselves in the position of not having three full qualifications at the end of their time at sixth form, since Core Maths is not a two-year A-level equivalent. They may be guided towards two-and-a-half courses by their institution, or they may have the chance to pick up an AS or, more likely, an EPQ in their second year, having done the Core Maths course in year 1.

Students who realise immediately that the lack of three full grades would disadvantage them later, in the process of applying to university, may decide instead to opt for another full A-level or equivalent. They elect to enrol on a different subject entirely, and do not take any maths at all.

### ***4.3.2 Students who do not wish to take A-level Maths but want to continue with some maths***

Some students, even students who have achieved the required access grade for A-level Maths, may not wish to take A-level Maths, but still want to include some maths in their programme. Maths may be supportive of, or in contrast to, the rest of their study programme. These are, presumably, the students for whom Core Maths was originally designed.

For these students, CM will be an extra qualification, useful to them in work, study, or life, and it will show that they have voluntarily kept up their maths. For them, Core Maths is a good option: it keeps their maths going during the post-16 phase. In their institutions, Core Maths may be designated as an “enrichment” or “extension”. They are motivated to study maths as an additional qualification beyond their main study programme, believing it is worth the extra effort. They may be higher achievers, but this is not necessarily the case.

### ***4.3.3 Students directed to take Core Maths as part of a pathway or programme***

In some of our case study institutions, as part of the recruitment drive and also in order to target Core Maths at groups who might benefit most from it, particular students are encouraged or even directed to enrol on the course. Staff at Dickenstein, for example, work hard to convince students that Core Maths will support their Applied Science BTEC course, and will enhance their applications to university. Recruitment may increase, but retention can be a major issue later on.

At Jones FEC and Coates Studio, Core Maths is offered as part of the TechBacc, but to small numbers (fewer than ten in each case).

### ***4.3.4 Students directed to take Core Maths because they do not have the required Maths GCSE grade to access other subjects***

Some students wishing to access particular subjects (e.g. Geography, Psychology, Biology), which have a level of quantitative or mathematical content, may present GCSE Maths grades which indicate that they may struggle with those other curriculum areas. Institutional policy may allow them to access those courses if they commit to enrolling on Core Maths as well. This group of students are often maths-averse, having attained just enough to pass GCSE with a grade 4 or possibly a 5, and their motivation can be low. Some students are resentful that they are being obliged to take Core Maths, especially as an extra course beyond their chosen main three, but some do accept the argument that it is to their benefit.

At Viana SFC, a view that there is not a sufficiently large target group of students who will opt into a maths course of their own free will leads to a policy to channel certain students onto the course. So, for example, students wanting to take Psychology, but falling short of the official entry grade of GCSE Maths grade 5, are accepted onto Psychology if they also enrol onto Core Maths. Staff have to work harder to convince students of the benefits of this recruitment policy, and the ability and attitude of the student cohort is now different.

### 4.3.5 Students who need a one-year option to complete their programme, particularly in year 2 post-16

A fourth group of students reach the end of year 1 post-16 having not achieved the standard to progress into the second year in one of their subjects. This could be decided by an internal assessment, or, less often now, by taking the AS exam. Needing a one-year course of some kind to complete their GLHs, these students may find themselves ushered onto Core Maths to fill their programme. Core Maths is one of only a few qualifications offered in our case study institutions as a one-year option, the other main one being the EPQ.

A-level Maths students may reach this point. Any student who fails or is graded with an E at the end of the first year may be advised, or may decide, to move to Core Maths instead of taking the second year of A-level. Centres which offer a one-year CM course find it enables this group of students to continue with maths and achieve a maths qualification (albeit not the one they embarked upon initially) at the end of the post-16 phase.

### 4.3.6 Prior attainment in mathematics and English

In this sub-section, we use NPD data from 2018 to compare three groups of Level 3 students, defined earlier in Table 2 (CM, A-level and Other Level 3 students), with respect to their GCSE attainment.

The following (Figure 9) compares the three groups defined above on mean GCSE Mathematics grade (overall mean 5.5 in 2018).

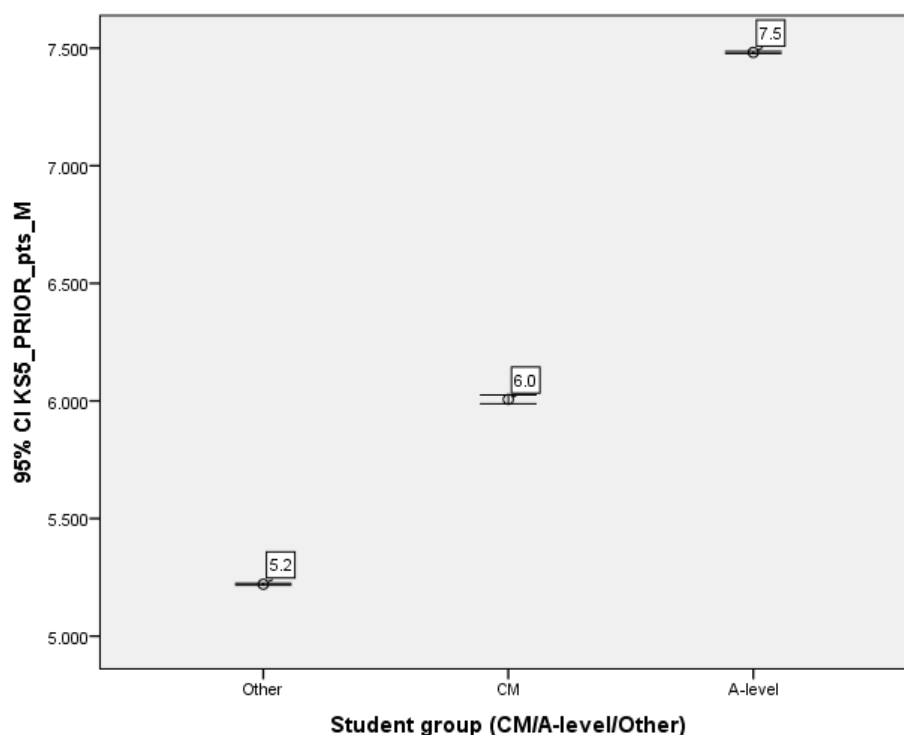


Figure 9: Mean attainment in maths at GCSE (NPD data 2018)

As we might expect, CM students are typically lower achieving in GCSE Mathematics compared to A-level students but are more highly attaining than other Level 3 students (see also Table 15). A similar pattern, with smaller differences, is present for GCSE English Language.

| Statistic and qualification        | Core Maths students | A-level Mathematics students | Other Level 3 students | Overall |
|------------------------------------|---------------------|------------------------------|------------------------|---------|
| Median Grade GCSE Mathematics      | 6                   | 8                            | 5                      | 5.7     |
| Mean Grade GCSE English Language   | 6.0                 | 6.8                          | 5.7                    | 5.8     |
| Median Grade GCSE English Language | 6                   | 7                            | 6                      | 6       |

**Table 15: Prior attainment at GCSE (NPD data 2018)**

However, the picture is more nuanced if we look at the online survey responses on GCSE access grades to CM. The minimum grade for access to CM was most frequently reported as a 4 (58 out of 108 = 53.7%), although free text comments in the survey indicate that this was predominantly on a case by case basis. This compares to around half of our case study institutions stipulating grade 5 for access to CM. Also, there was little variation in minimum required grades by institution type (e.g. FE, SFC, school) in the survey data.

### 4.3.7 Relationship between CM attainment and GCSE Mathematics and English

The correlations between CM outcomes in 2018, and GCSE grades in Mathematics and English Language, are  $r=0.59$ , and  $r=0.34$  respectively ( $n=6,561$ ,  $p<0.001$  in both cases). So, typically, students scoring more highly in GCSE do score more highly in CM, and, as we might expect, this effect is stronger for Mathematics than it is for English. However, the magnitude of the correlation between Mathematics GCSE and CM is not especially strong, suggesting, perhaps that, the skills required for success in CM are not exactly those required in GCSE Mathematics.

We have not presented here a value-added analysis (from GCSE) of influences on attainment in CM, mainly because our case study work suggests that there is not always such a focus on grade outcomes for CM as there can be for qualifications on which an application to university or apprenticeship can depend. Rather, the intention is often to develop skills and confidence in using and applying mathematics, taking the emphasis away to an extent from the summative assessment at the end of the course. As the extent to which attainment in CM is the particular focus of the course is not captured in the NPD data, we believe such an analysis would not be particularly revealing.

### 4.3.8 Section summary: key findings

Although the qualification is aimed at any student who has achieved a standard pass (grade 4+) at GCSE Mathematics, it is not always the case that any grade 4+ student is offered the course (4.3). The access grade in some institutions is a 5.

Operational issues within institutions can constrain or prescribe the CM target group (4.3). CM may be offered primarily to students who have not achieved the access grade for A-level Mathematics, or students who need to carry on with their mathematics in order to access other subjects (e.g. Psychology, Chemistry). Linking CM with other subjects can result in students feeling resentful about CM, and mandating them to study CM as a requirement for entry onto their main programme can lead to retention issues (4.2.1, 4.2.2). Alternatively, CM may be offered as an enrichment or extension activity into which any student can opt. This strategy tends to result in small numbers, due to low student appetite for the qualification.

CM students are typically lower attaining at GCSE in Mathematics and English Language than are A-level Mathematics students, but are higher attaining at GCSE than other Level 3 students as a whole (Figure 9 and Table 15).

## 4.4 Core Maths builds on GCSE, offering progression to authentic applications of mathematics

**Core Maths qualifications should consolidate and build on students' mathematical understanding and develop further mathematical understanding and skills in the application of maths to authentic problems, thereby offering progression from GCSE mathematics**

(Core Maths: Technical Guidance)

### 4.4.1 Building on GCSE

Teachers and students speak in positive terms about the student experience of Core Maths being totally different from their GCSE experience. Some teachers suggest that students who have previously not achieved highly in maths, in terms of their GCSE grade, can flourish with CM due to its different emphasis and approach. Concentrating on problem solving and deeper understanding, as opposed to rote learning and repetitive practice of content and procedures, gives those students a renewed confidence in their mathematical abilities.

Some teachers express the view that students who have done well at GCSE, and particularly those who have taken the Higher paper, will generally find Core Maths accessible. One Jones student, for whom CM is obligatory because it is linked to his IT course, started by saying that he “would have preferred to have the option not to do it”, but in the end says he would recommend it to other students:

*“If they find GCSE easy, then it is, it is generally easy. It's just a case of having to trudge through it and get the qualification.”*

Staff say students who have taken the Foundation paper will struggle more, due to not having had access to enough of the GCSE content which comes into CM. There is also a view that grade 4 and 5 students, even those who have taken the Higher paper, may not have a sufficient mastery of GCSE concepts to cope with CM easily, and some teachers find they spend a lot of time going over GCSE content, especially with Foundation students. The Rousseau CM teacher comments that some GCSE resources are useful for revisiting GCSE concepts, but that she is careful to avoid students knowing they are doing GCSE tasks, because she wants them to feel they have progressed.

At Jones FEC, students with a grade 4 are encouraged to re-sit GCSE in year 1 of post-16, consolidating content, before moving on to CM in the second year. One of the CM teachers at Jones comments with some frustration that his CM students had barely scraped their Level 2 maths, let alone starting on Level 3 maths, saying that in fact GCSE grade 4 is a very low baseline from which to build. This very opinion is what leads other centres to stipulate GCSE grade 5 to enrol on CM.

### 4.4.2 Realistic, authentic maths

The real-life, applied nature of Core Maths is very positively received, by students and staff alike. Comments are made particularly about the real-world relevance of Core Maths, especially in contrast to the abstractions of A-level Maths, of which algebra is frequently mentioned as an example. The Head of Maths at Palis has a joke about this:

*“the deeper you go into maths in the second year of the A-level, you, you are getting into territory where there, you know, you're talking about just totally abstract concepts that, there isn't something in real life you can say to a student. You know I mean, I joke with the students that when, in, in the second year, in Year 13 when they do exponential graphs that go up like that [gestures], and I tell them, that when you turn up the volume, it doesn't go up in a straight line, the numbers they go up like that, and I always say, well, there you go, that's this year's real-life application because that's one thing out of a whole year of maths that I can definitely say here's how you can understand this because this is a real-life thing that you use, you see.”*



Display board in a maths classroom at a case study school

Similarly, one of Coates Studio's CM teachers talks enthusiastically about the usefulness, relevance and real-life application of CM, as opposed to the dryness of A-level. He describes CM as “a really good qualification”. Teachers across the case studies state how free it feels not to be teaching to the test in the way they feel they are doing with GCSE and A-level Maths.

One of Lions's CM teachers is convinced that students can be “hooked in” by starting with the personal finance content. He, along with other teachers, say that they use real, relevant issues and current news stories to stimulate tasks. Students are often encouraged to bring questions in to pursue in class. One of Mumford's CM teachers says the lessons are very interactive and investigatory, often without writing an awful lot down, in contrast to other lessons where everything is based on evidencing ‘learning’. He describes the shock students may experience, when they are told they do not have to find a right answer, just a feasible one. Teachers more widely say students take a while to get used to this idea, since it is not what they have previously expected from maths. The Mumford teacher adds that they start with the maths, and the content, not with the assessment; the assessment comes later, when he shows the students the sort of exam questions they could expect, and he relates their surprise at how much they can already do.

CM does have an examination, of course, though it is widely felt to weigh much less heavily on both teachers and students, because it does not seem to have such an influential place within the performativity agenda as, for example, GCSE and A-level Maths. All the same, teachers have had to get to know how the CM exam works, and become familiar with the types of questions and the application of mark schemes. This has come about at a time when the GCSE and A-level have also been reformed; teachers are coping with multiple changes simultaneously, which is stressful and labour-intensive.

Teachers mention how they become familiar with the layout of papers and question types over time. There have only been four Core Maths exam sittings (2016 to 2019);<sup>41</sup> exam boards and other sources have produced practice papers, though there is a range of views as to how closely these resemble the real thing, and how plentiful the supply is. Some teachers say they construct Core Maths-style questions to give to the students, saving the actual past papers for formal tests. They also relate how, once the pre-release material appears, shortly before the exam itself, they attempt to

<sup>41</sup> In 2020, due to the COVID-19 pandemic, no national examinations have taken place.

predict what questions might appear on the actual exam. This is often done in conjunction with colleagues locally.

Of the comments on the exams themselves, two main themes recur. The first is the wordiness of some questions, leading some students to say they feel questions are long-winded, often with long stretches of text rather than maths in the questions. Some students said that it can be time-consuming to pick through the wording to get to the maths, and that giving answers often involves a good deal of writing. Others said they enjoy this aspect of the task. However, there is acknowledgement that students need to get used to such tasks, since in the real world we do not generally find sums neatly laid out to do, but have to sift through information and work out what maths is needed to solve a problem or address a task.

The second notable comment is about the difficulty of teaching students to answer the estimation questions, which may demand more from students' knowledge of the world than from their abilities in maths. Some students also feel uncomfortable with these tasks. Fermi estimations are cited most frequently by students when asked what they do not particularly like about CM. Viana SFC's CM teacher also mentions that it is especially tricky to understand or be certain how estimations questions are marked.

One of the Lions CM teachers says that he has a slight concern about whether the exam questions purporting to be realistic are truly realistic. For example, he mentions a question about measuring the circumference of a rabbit's head, saying that whilst this uses a real concept, rather than an abstract one, it still begs the question when a student might need to measure a rabbit's head.

### 4.4.3 Attainment in Core Maths

Figure 10 shows the change in grade profile for all CM entries from 2016 to 2019 based on aggregated awarding body data:

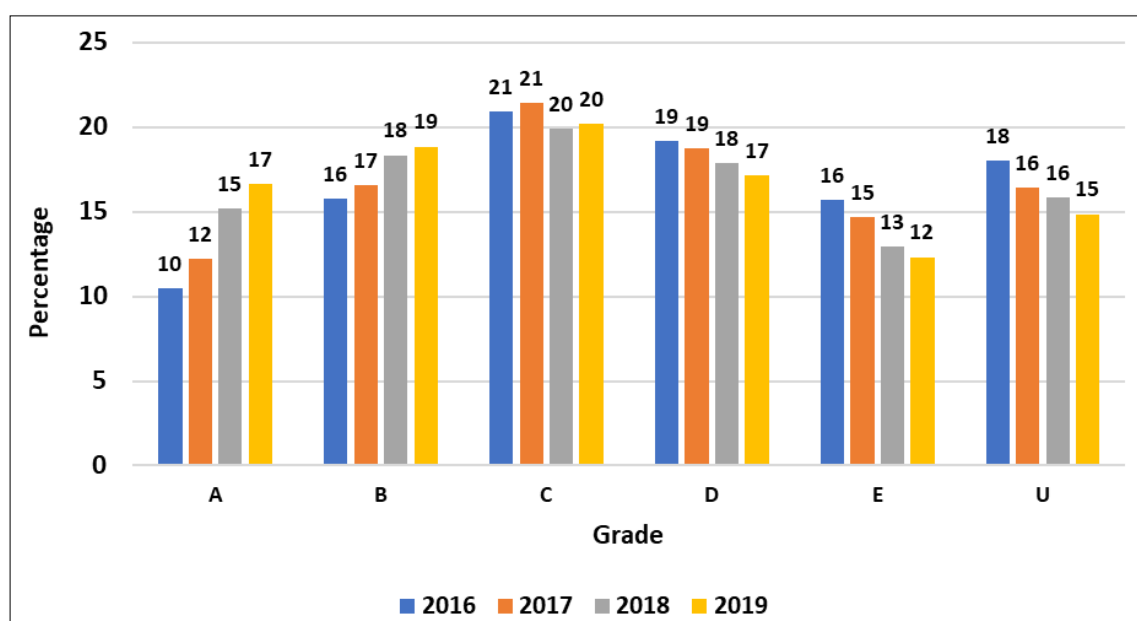


Figure 10: Percentage in each grade – 2016 to 2019 (Awarding body data)

There has been an overall improvement in grades over time. The percentage of A and B grades has increased year on year, whereas the D, E and U grades have all declined. The median grade has changed from a D in 2016 to C in 2019. The percentage of grades A and B, which is the CM requirement for discounted entry to specified courses at the Universities of Bath, Sheffield and York,<sup>42</sup> has increased from 26% to 35% over this period. To an extent, this increase might be the result of a new qualification bedding down in institutions.

The general feeling in the online survey was that CM results were 'good' (57.4% agreeing, at least, with this statement).

<sup>42</sup> <https://amsp.org.uk/news/the-universities-of-sheffield-and-york-add-their-support-for-level-3-maths-including-core-maths>

#### 4.4.4 Adult learning

A number of stakeholders, including a manager from a city council Adult Education Service, an FE teacher, and local government officers for skills and employment, spoke about the importance of continuing education, and specifically the fact that, at the moment, adults cannot access Core Maths without having to pay for it. They highlight how useful Core Maths would be to adult learners looking to improve their employment prospects, particularly because of the applied elements of Core Maths. Adults taking or retaking GCSE Maths have no qualification to which to progress, once they have achieved grade 4 or more in Maths GCSE, apart from A-level Maths, which may not be the appropriate course for them; a more applied course would be more appropriate for many.

#### 4.4.5 Section summary: key findings

The real-world, applied nature of the mathematics in CM, and the financial topics in particular, are greatly appreciated by staff and students (4.4.2). CM is perceived to be more relevant than any other maths experienced by teachers or students. CM students are generally positive about the usefulness and relevance of the mathematical skills they have developed, and the confidence they build, through taking CM.

There is a perception that students who have done well at GCSE Mathematics will find CM to be an enjoyable, manageable course, even when taking it in addition to their main programme (4.4.1). Students who have taken Foundation GCSE may find it more difficult than those who have taken Higher, because they have experienced a narrower range of content. However, the accessibility of CM can bolster students' confidence in their mathematical ability, allowing students who previously struggled with mathematics at GCSE to thrive.

According to a range of stakeholders, adult learners, on gaining their GCSE, would benefit from progressing onto CM if they were funded to do so (4.4.4). Students and teachers report that the relevance and applications of maths within CM should be made available in a corresponding pre-16 qualification at Level 2 (4.4.1).

## 4.5 Core Maths prepares students for the range of contexts to which they will progress

**Core Maths courses should prepare students for the varied contexts they are likely to encounter in vocational and academic study and in future employment and life**

(Core Maths: Technical Guidance)

The issue of HE signalling is given its own section later in the report, since it was also singled out for special attention in the policy documentation. In the current section, we set out our findings regarding the usefulness and relevance of CM in preparing students for the mathematical needs and demands of the varied contexts they will encounter, presented together here under the themes of *Supporting future study*, *Higher education destinations*, *Employers' views on CM*, and *Life, society and citizenship*.

### 4.5.1 Supporting future study

Interviews with Q-Step representatives from a number of UK universities, AMSP regional and national leads, UCAS and awarding body representatives, HE admissions staff, desk research exploring university websites, and our three rounds of qualitative fieldwork in our case studies, have provided data which indicate that mathematical preparation is considered essential for a range of further study opportunities. Stakeholders refer to the narrowness of the post-16 curriculum in England, and the problematic divide between arts and sciences. A perception of disadvantage is further heightened when English students are compared with international students, who have taken a baccalaureate and have experienced a much broader and/or more rounded education. There is also the matter of confidence and competence, which can be enhanced by the extended study of maths beyond GCSE.

Q-Step co-ordinators were keen to stress the importance of a continuation of mathematical activity beyond the age of 16, rather than leaving off maths and picking it up again as an undergraduate, which, in their experience, can be problematic. This group of senior academics also told us of their experiences of students beginning undergraduate degrees with a lack of understanding of even the maths they learned at GCSE, because they had been taught to pass the exam, rather than developing understanding or skills of application. AMSP leads and HE programme leaders believe that there are many courses for which students would be better prepared if they had had some experience with problem solving and with applications of maths, even if they attained a grade 5 or 6 in GCSE Maths. Both AMSP and Q-Step representatives spoke about the nervousness of HE in publicising that undergraduate courses would require some maths, in case that meant students were discouraged from applying.

Interviewed at the beginning of their CM course, students often cited their belief that CM would be useful for university admission, a belief born of information given to them by their teachers. At our 2018 and 2019 visits, which took place at the end of the academic years, students had had a variety of awakenings relating to the veracity of this claim. Those completing their course generally still believed in the value of CM, including referring generally to the benefits of having a post-GCSE qualification in maths. Their emphasis became more about the usefulness of the skills and experience they had built up through CM, including that this would be good for the maths they would face in their prospective university courses, rather than on the exchange value of the qualification as part of an admissions package:

*“Er, obviously, you talk about it not being accepted, and I can agree with that, but the skills definitely will help”*

(Mumford student)

The exception to this is when students knew they were going to include the UCAS points from CM within their university application.

The only case study which explicitly positions CM as a course targeted at preparing students for HE is Jones FEC. Here, Core Maths is specifically targeted to support IT students. Students are made aware that it is the request of the accrediting university for the Level 4 IT programme at the college that students should continue with maths between GCSE and moving on to undergraduate studies.

### 4.5.2 Higher education destinations

We have analysed national higher education participation data for 2017 to investigate student progression from CM into HE. The key findings of this analysis are:

- Around 50% of the first cohort of CM students who had completed two years post-16 went directly into HE.
- Progression rates into HE seem broadly to reflect CM specification participation rates. In other words, there is no evidence that students taking particular specifications progress into HE at higher rates than others.
- Former CM students in HE are more likely to be male compared other HE students (58.3% vs. 42.3%). Note this is from the first CM cohort, which was more male-dominated than later ones (Figure 2).
- Students who had studied CM were less likely to go to higher-ranked HE providers (e.g. Russell Group) compared to their non-CM peers (13.5% of CM students vs. 21.8% of non-CM students entering Russell Group institutions).
- Favoured HE providers for former CM students are: De Montfort University, Nottingham Trent University, and The University of Central Lancashire.
- The most popular undergraduate courses being taken by former CM students are Computer Science, Mechanical Engineering and Psychology.

In the online survey data, there was some ambivalence with regard to the extent to which CM helped students in progression to HE, with 45.6% of respondents (at least) agreeing that this was the case.

### 4.5.3 Employers' views on CM

Employers, we found, are unlikely to be aware specifically about Core Maths, or its particular content or approach. One school Principal whom we interviewed went so far as to say that employers are unable to keep up to date with understanding all the curriculum and qualification reforms, and may well assume that Core Maths is, or is equivalent to, A-level Maths.

Students are likely to say that they do not believe employers and apprenticeship providers would be impressed by the fact that they have CM, because employers and apprenticeship providers are unlikely to be aware of CM. However, they believe those employers and providers would be impressed by the fact that they have the knowledge and skills from the course, if the student was asked about it at interview.

Employers are, indeed, likely to express a view that future employees need mathematical and analytical skills, and the ability to think critically about facts and figures they will meet on a regular basis in their work. An example which arises frequently is that of understanding how to work with percentages, in such contexts as understanding interest rates, or percentage change over time. A view is emphatically expressed that it is not necessarily high level or advanced maths which is needed; rather, students need to be able to utilise and work with basic maths, and particularly to be able to take a concept or a skill, and move outside one context to apply that concept or skill successfully in an unfamiliar context. They need to be able to look at data, whether in a table, on a graph, or in numerical form, and extract some intelligence from or comment critically on it.

As we found in the data from stakeholders within education, employers were critical of the current system of curriculum organisation, whereby post-16 students have to specialise in just a few subjects, which is seen as a barrier to more students taking maths of any kind. In addition, there is the fact that maths is seen in isolation rather than as a subject which underpins broader tasks, or which can be applied more widely. This view would point to a belief that maths within other curriculum subjects is an important post-16 route by which students can continue working with mathematical and analytical concepts without taking a separate maths qualification. The embedding approach introduced in recent A-level reforms, ensuring that a percentage of assessment is specifically quantitative in the appropriate subjects (see the Introduction to this report), would seem relevant to this view. Equally, we found a view that undergraduates of as many subjects as is possible need to be using maths and quantitative skills - particularly understanding data - as part of degree courses, in preparation for employment.

We heard from students, teachers and managers about how various elements of the Core Maths specifications and options can help prepare students for employment. The financial aspects of Core Maths which are found in most specifications could be relevant to any student in any future job. Vocational areas such as hairdressing could benefit from linear programming, which is about problem solving, addressing business challenges such as making a business plan and making a go of your own business. One student relates her Health and Social Care BTEC course to Core Maths, explaining that her confidence and ability in reading graphs and doing calculations in Health and Social Care had been enhanced by her experience in Core Maths. Students can relate the statistical, data handling and interpreting graphs elements of Core Maths to a number of career ambitions they hold. Arnold's Curriculum Manager for Maths and English explains that "when they see the relevance of the maths, they're more engaged in it", and highlights the importance of knowing how central maths can be to particular jobs:

*"...if it's in their vocational area, and, you know, it's hairdressing, they're looking at ratios and things like that then, it's, they buy into it a bit more 'cause it's so important then, and it's, well what would the consequences be if you get the maths wrong?"*

One local issue, which may exemplify a more general attitude, is one which we saw manifested by a large manufacturing and engineering company which is a relatively common destination of students from two of our case study institutions. The company has been used to recruiting students onto their degree apprenticeship who have achieved highly in the triple BTEC in Engineering, and also have AS Maths. The employer says that, if there is a risk of the student failing or struggling in any component of the apprenticeship, it will be in the maths component, and therefore they need to be sure that the student has the right maths aptitude. However, now that schools are not routinely offering students the chance to take AS Maths, and students generally need to commit to the full two-year A-level Maths course, the employer has increased its requirements to the triple BTEC plus A-level Maths. This is the only qualification familiar to them. This, according to our case study institutions, is a huge challenge to students, both in terms of the amount of work required to take on the equivalent of four courses, and also in terms of the standard the employer is demanding; the case study institutions also point out that it disadvantages students who are not offered the chance to take that combination, which exceeds the funding framework (three courses/equivalent) for most institutions. Staff in both the case study institutions highlighted that students with the BTEC plus CM would be sufficiently well prepared for the apprenticeship, but that the company does not currently understand what CM is.

The Principal of one of those case studies says that employers do not understand BTEC and they do not understand CM. He is keen that employers ought to recognise a range of post-16 maths routes, including CM. A senior manager in another of the case studies says he believes a Core Maths student would, in fact, be better prepared for a range of employment than one who has AS or A-level Maths, because of the problem-solving and applied elements of the Core Maths course. Other teachers in other institutions also express a view that a student who has studied CM is better equipped, all things being equal, than a student who has not studied CM, to take on an apprenticeship. However, according to our evidence, companies and businesses offering apprenticeships are unlikely to know about CM, unless an individual has come across a student who is studying Core Maths. Rare examples of awareness of CM came from a student whose aunt had heard of CM, because she worked in a bank where a CM student had done some work experience, and another student whose father is in business and appreciates how CM could be useful in the workplace.

A view is expressed that careers advisors and careers professionals who work across the school and college sector need to be more aware of Core Maths as a helpful qualification that can enhance an application for any kind of progression. As one Mumford CM student says:

*"I think it needs more, I think it, to put it bluntly, I think it needs to be taken more seriously overall, especially by like, not just by universities, schools as well."*

#### 4.5.4 Life, society and citizenship

Students themselves cite the financial aspects ("tax and stuff" is a phrase they often use) of CM as those elements which have been most relevant for them. The focus on real-life maths, maths that students will encounter in their daily

lives, maths which is found in newspapers and media reports, which is therefore engaging, is widely acknowledged. They gave examples such as tax and insurance, loans, mortgages, and using spreadsheets to understand paying money back with interest. Students also talked about “understanding statistics in advertisements”, and specific examples such as helping a parent get a good exchange rate when they needed currency for a holiday, as well as many general comments about CM being useful in life:

*“And it also gives people a deeper understanding of when you, like, you know, grow up, and you’ve got a job, what you should do when you, you know, do your taxes, when you do, er, mortgages, all of that”*

(Arnold FEC student)

There is a broad agreement amongst staff that all students should be taught about financial maths, budgeting, tax, interest rates and mortgages, and taught to exercise critical awareness around statistics in the media and other public arenas. Ball’s Head of Maths is of the firm opinion, repeated at each visit, that all students need and should be studying at least the financial aspects of CM, because this is so fundamental, and that it should be taught in registration periods if that is the only way it can be accessed by all students.

This view of at least the financial parts of CM puts it into the category of Personal, Social and Health Education. In several of the case studies, CM is positioned in the enrichment slot in the timetable, making it the qualification which takes the student beyond their curriculum choices, offering greater breadth of study. As the CM teacher at Donaldson says:

*“...we worked taxes out nationally, they picked the job they wanted to get, when they’re older, so they picked that, looked at the salary, worked out the tax, worked out the National Insurance, then they worked out the houses they want and what mortgage they’d have to pay and the water, and then they realised how much the money was going, and it was like, it was quite an eye opener to them... it made them realise actually, the realities of running a house, with paying bills and, it gave a bit more, it was a lot more of a real context and you know, yeah, we need, it’s worth knowing this...”*

The combination of financial and critical maths is described in the following quote from Arnold’s CM teacher:

*“...maths for personal finance, they love it. They, when you start teaching them they always say, yeah, we should have learned that kind of maths, how to calculate our mortgage, how to plan our student loan and those kind of thing... That’s what we need. And this is where the joy starts. And even the statistics, they know that oh, actually now, statistics help us to take the right decision. We can, we can create facts. Yeah, we’re not gonna have just to run our life with rumours and, and trend.”*

#### 4.5.5 Section summary: key findings

Employers and HE representatives stress that they need individuals to come to them, not necessarily with advanced maths skills, but with fundamental mathematics skills and the confidence to use those skills fluently (4.5.3).

Higher education admissions tutors are not yet, to any significant extent, cognisant of the benefits of CM to students who have taken the course (4.5.1). Employers are unlikely to have heard of CM, and therefore cannot be expected to understand the benefits it brings to students (4.5.3).

The positive reception of the financial aspects of the course leads to a general perception that all students should be studying at least those aspects, which will help when dealing with mortgages, tax and interest rates, and in viewing the world with a critical eye (4.5.4).

## 4.6 Core Maths develops mathematical thinking and confidence

**Core Maths qualifications should foster the ability to think mathematically and to apply mathematical techniques to a variety of unfamiliar situations, questions and issues with confidence**

(Core Maths: Technical Guidance)

### 4.6.1 The teaching of Core Maths

Donaldson's Head of Maths describes his typical approach to CM as setting students off with a task or a problem and seeing where it goes. He describes how there needs to be a transition from GCSE to CM lesson style, as students get used to a different way of working. Viana SFC's CM teacher echoes that students develop gradually, over the first year of their CM course, into independent mathematical thinkers with a new, problem-solving approach to learning. These teachers who promote and facilitate wide-ranging and far-reaching lessons, let discussions wander, and allow for multiple solutions, are following the spirit of Core Maths.

At Arnold FEC, the Curriculum Manager for Maths says the learners do not get on with an overly academic approach. He values his teacher who, he says, has creativity, and can teach content in a way that the learners will understand. The CM teacher herself stresses that it is not necessarily about knowing a lot of maths, but about knowing how to make it accessible.

We found a range of views about how CM teaching should be approached. Evidence from our study shows that there is not always a clear understanding of the aims and objectives of the CM course, or knowledge of what the suitable pedagogy is intended to be. Some teachers say they approach CM in the same way they teach other courses such as GCSE/A-level: heads down and getting on with tasks on paper. Some of these teachers say they are happy with their approach because their results have been satisfactory or even good. However, these teachers, when informally observed, are not always approaching CM in the freer, more exploratory way advocated for CM. One of the CM teachers at Mumford describes a maths teacher mindset, leading to some teachers being reluctant to teach CM with a different approach, and says CM teachers are getting used to the different demands of the new course over time.

Some teachers and Heads of Maths admit that the first year of running CM was nerve-wracking, since the intended pedagogy and the manner of assessment are different from other courses they teach. The second and subsequent years are described as more comfortable and more straightforward. There is also evidence that some teachers worry about whether they are doing it "right", and of teachers wanting reassurance that what they are doing is going to work. Several of our case study CM teachers have become CM markers, and feel they have acquired some good insights into the assessment process at least via that route.

All Core Maths classes in our study were staffed by specialist maths teachers. Non-maths-specialists are teaching maths within the case study institutions, usually in Key Stage 3, but not currently teaching CM. There was evidence that centres had considered using teachers from other departments (e.g. Psychology teachers) to teach CM, but this had not happened anywhere, mainly due to timetabling constraints as opposed to any ideological or educational reasons. One of the CM teachers at Jones FEC told us that, in the previous year, a Computing teacher had taken Core Maths (the CM students at Jones were all IT students, so the staffing could have been linked to their programme), but after a review this was changed so that only maths teachers could now teach CM. There is a certain amount of evidence of other subject teachers being consulted as to how CM might help with their subject, and where links might be found: for example, Coates Studio's Head of Maths says that there have been explicit conversations asking other subject teachers where maths comes into their syllabus; at Jones FEC, there has been communication with the Psychology lecturer about where CM overlaps with the Psychology syllabus.

The online survey data also suggest that almost all of the teaching of CM across the country is being done by mathematics specialists (94.3% of survey institutions reported that this is the case). The free text comments on this issue suggest a degree of openness to non-mathematics specialists having an input into particular lessons or topics but some reservations in this regard:

**I don't think it necessarily needs to be maths teachers but I do think there are specific skills that dedicated maths teachers may have that are different in emphasis to teachers of other subjects. It is still essentially a L3 maths qualification and it is potentially unhelpful to have non-specialists teaching it.**

(Maths teacher in a school)

Careful thought is often given to the allocation of CM within maths departments. For example, the Vice Principal at Viana SFC talked about consistency and quality of teaching staff, and described allocating their “best teachers” to CM, referring to the current CM teacher as a young teacher with energy. In several of the case studies, the CM teacher is the person who used to teach Use of Maths; in others, it is, by design, someone who used to work outside education, perhaps in industry. The initial allocation is quite important because, in many cases, the first teacher develops the course and scheme of work, creates resources, and often continues teaching the course, potentially developing the course with their own style. In some centres the course is taught by more than one teacher, but there is evidence to show that this does not necessarily benefit students, particularly if there are only one or two lessons a week, which makes it difficult for a relationship to develop between teacher and class.

The sharing of groups seems to work better in schools, where teachers are more likely to know the students, having taught at least some of them previously. Accordingly, the Head of Maths at Lions is keen to spread out the opportunities for teaching CM amongst his maths department, of whom six now teach CM, two teachers sharing each of the three groups. He has been bringing a new teacher into teaching CM each year to build up capacity. They also divide up topics on the syllabus according to what teachers' specialities are. Similarly, choice of specification and option can depend on what staff are comfortable teaching: nobody at Lions wanted a statistics option, so the choice of specification and option reflects that, whereas at Palis, the CM teacher is happy teaching the statistics option, since his degree, though not in maths, included statistics.

The reported teacher shortage does not currently seem, from our evidence, to be an insurmountable barrier to the teaching of CM. However, one of our case studies did experience a redundancy: one of only two teachers at Mori SFC was made redundant following a merger between two colleges, which resulted in CM provision being withdrawn, since the remaining teacher was needed to cover all the A-level Maths teaching.

Many teachers reported that teaching CM has had a positive impact on their practice. Teachers said they adopted CM teaching approaches, ideas, activities and style more widely across other maths groups such as GCSE and in Key Stage 3. Teachers and institutions that have decided not to offer CM will not see the benefits of such influences on wider teaching.

Group sizes are much smaller in CM than the students are used to generally at KS4, or in A-level groups. However, even with as few as two students, differentiation is still necessary: at Ball, in the Y13 group of two, for example, one student was very much interested in maths to support other subjects, whereas the other student, taking languages, is doing maths to keep her skills up. The Y12 cohort at Ball in 2017-18 was just one student, and the teacher remarked on how intense the lessons could be; on the other hand, it was easy to tailor work to the student's interest.

Students reported that lessons were usually different from GCSE maths lessons, though it is difficult to gain any real purchase on this difference since post-16 students form new groups from a number of different schools and indeed classes. They often felt that now they learned maths in new ways, including, for example, more group and project work. Sometimes students felt that there was an overlap of content between CM and GCSE, but this was usually seen as reassuring rather than negative.

## 4.6.2 Section summary: key findings

CM pedagogy sometimes promotes a new style of thinking and working in the classroom (4.6.1). Whilst some teachers adopt an approach which is in keeping with the exploratory and open-ended methods advocated for CM, others maintain a similar style of teaching in CM lessons as in other classes (e.g. GCSE/A-level).

CM is being taught predominantly by mathematics specialists (4.6.1). Care is taken over who within the maths department is allocated the CM teaching. There is a general feeling in schools and colleges that the course should indeed be taught by mathematics teachers.

CM teachers are positive about the course, typically enjoying the greater freedom they have to allow a lesson to flow in different directions, and a lighter burden which, they say, contrasts with the pressure of hurrying through lots of content and preparing for (other) high-stakes exams (4.6.1).

Students can take a while to adjust, particularly to open-ended tasks, or where there is not one right answer.

## 4.7 Core Maths qualifications are distinct from A-level Mathematics

### Core Maths qualifications are distinct from AS and A level mathematics

(Core Maths: Technical Guidance)

#### 4.7.1 Preparation of teachers to teach the new qualifications

There are many positive stories about teaching CM. The CM teacher at Dickenstein SFC says she enjoys teaching CM because it is totally different from the A-level. However, the evidence suggests a lack of co-ordination for training and supporting the development of CM, particularly following the initial CMSP input to Early Adopters and Early Developers. Apart from the support that was available from the CMSP for a small number (150) of Early Adopters, we did not find evidence of an organised training programme for schools or individual teachers. The DfE dissemination of information about CM, if any, was limited or indeed ineffective, as not many schools nor teachers knew about these new CM qualifications. Evidence suggests that there was little preparation for the nationwide rollout of CM; rather, the spread of CM was intended to be “sector-led” (Education Development Trust, 2018). A couple of CMSP advisors are mentioned several times in widely different geographical areas, suggesting that it was left to a few key people to provide support across England. The awarding bodies had not produced specifications when CM teaching first began in the autumn term of 2014, and everyone concerned was working with limited information.

It was not unusual for teachers to tell us that they had not received any training before teaching CM. There was no point of reference for many teachers, who do value talking to other teachers to compare notes and share ideas. There is also evidence of other teachers, such as the CM teacher at Mori SFC, saying they did not feel they needed any training, since the content was simple and they teach it the way they always teach. This results in their CM lessons being no different from their A-level lessons.

Evidence shows that, where training was provided, teachers did not know whether it was the Maths Hub, the CMSP, the exam boards or other bodies providing it. Evidence also reveals that there was training which teachers thought was not always productive. They report an emphasis on marketing and promotion of CM at training events, rather than on supporting teachers in how to teach CM. Indeed, the CM teacher at Jones FEC mentions that it has felt, even at more recent sessions he has attended, as though it is more about selling the course to teachers who are not already doing it, rather than offering something new by way of support or training to teachers like him already offering the course.

Teachers at Lions Academy - an Early Adopter, a lead CM school and a teaching school - had to support others within their own teaching alliance and also beyond, whilst feeling they were not at all expert. One CM teacher at Lions, who was also an NQT in that first year, says she and the other CM teacher lived “on a wing and a prayer” in the first year and then had to train others. Interestingly, she is one of the teachers worrying about whether they are doing it “right”. Often teachers report that the most useful aspect of training events has been the networking opportunities and the chance to talk and share experiences with other CM teachers. Ball’s Head of Maths remarks about her experiences attending local network meetings and training, and that nobody she has come across claims to have worked out the optimum way of implementing CM, which seems to be something many teachers are seeking. At Donaldson and at Viana SFC, the Heads of Maths say that, when the CMSP disappeared, the meetings that they had attended in their respective areas stopped.

The Curriculum Manager at Arnold FEC said that there had been ETF<sup>43</sup> funding for colleagues at the very start of the delivery of CM, and so two teachers had been on a CMSP course. Relatively few FE teachers teach Level 3 maths in any form, so any potential CM teachers are likely to need training. The Curriculum Manager said he would like to take advantage of free training courses offered by the Maths Hub, getting several of his staff up and running with CM, but, as far as he understands, there is no money to cover the cost of teachers going out of the classroom.

At the second round of fieldwork, Mumford’s CM teachers report that the local Maths Hub has been a useful source of information. This was an interesting finding, because at the time of the first round of fieldwork there had been

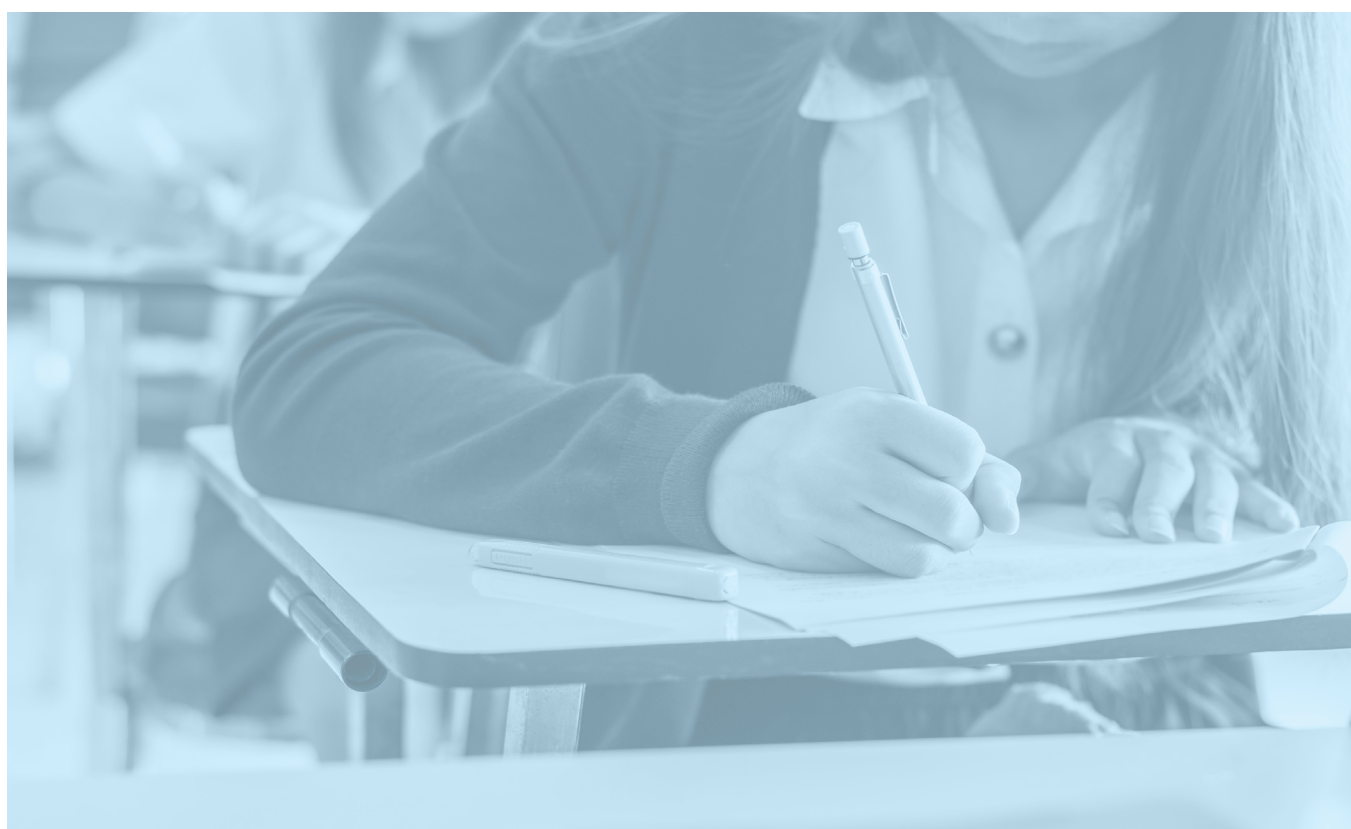
<sup>43</sup> Education and Training Foundation, which offers CPD for FE staff.

no contact between Mumford and the Maths Hub. The teachers say it has been good to hear what is happening in other institutions, and to gain reassurance from other centres. They particularly appreciated looking at their own exam results in comparison with other centres using the same exam board. They also specifically mention that an academic from the local university has spoken at a Maths Hub meeting about the need for post-16 students to be studying maths, as it makes their job much easier when the students arrive in HE with greater skills and confidence. Significantly, it was at the Maths Hub that the Mumford teachers found out about the AMP funding.

#### **4.7.2 Choice of awarding body**

Teachers have different experiences with, and preferences for, awarding bodies. Sometimes their beliefs appear contradictory. The CM teacher at Dickenstein SFC is an AQA marker, but prefers OCR, which Dickenstein offers, because she says AQA is more difficult. However, the CM teacher at Coates Studio says she is glad they are doing AQA because it is much open and has less content, allowing for more open lessons, and that the AQA exam questions are more structured. Donaldson's Head of Maths also prefers AQA, and says he teaches it with a real freedom, but his choice was influenced by the fact that others within his network were doing AQA. Meanwhile, the Head of Maths at Ball says she would hate to mark the AQA paper because "every child could have a different answer". The Head of Maths at Palis is one of the few case study teachers we spoke to who were supportive of Edexcel, saying he likes the fact that the assessment requires students to answer relatively short questions which test their understanding of the passages given. He argues for assessing for understanding or reasoning, over being given something open and having to do lots of writing.

The choice of exam board was largely dictated by teachers' specialism, and by loyalty to, or familiarity with, resources available from certain exam boards, and with the exam paper and question style. For example, evidence shows that the choice of OCR/MEI can be related to a liking for the Integral website. Teachers or schools may have an existing link with a person, board or organisation who could be called on to help, including others within a local network whose recommendation they trust. Teachers also say they think about the students' needs, roughly mapping the options onto subject choices of students' wider study programme, though in reality this can be difficult when students study CM alongside a range of other curriculum areas. The suitability of a specification for certain students is least likely to have influenced choice, though teachers may say they gave it high consideration.



### 4.7.3 Specification breakdown: national data

The awarding body data on CM entries are broken down by specification in Figure 11 and Figure 12. The AQA specification predominates, a dominance which has grown stronger in the most recent cohort in 2019 at the expense of the other specifications which have declined in entry numbers between 2018 and 2019.

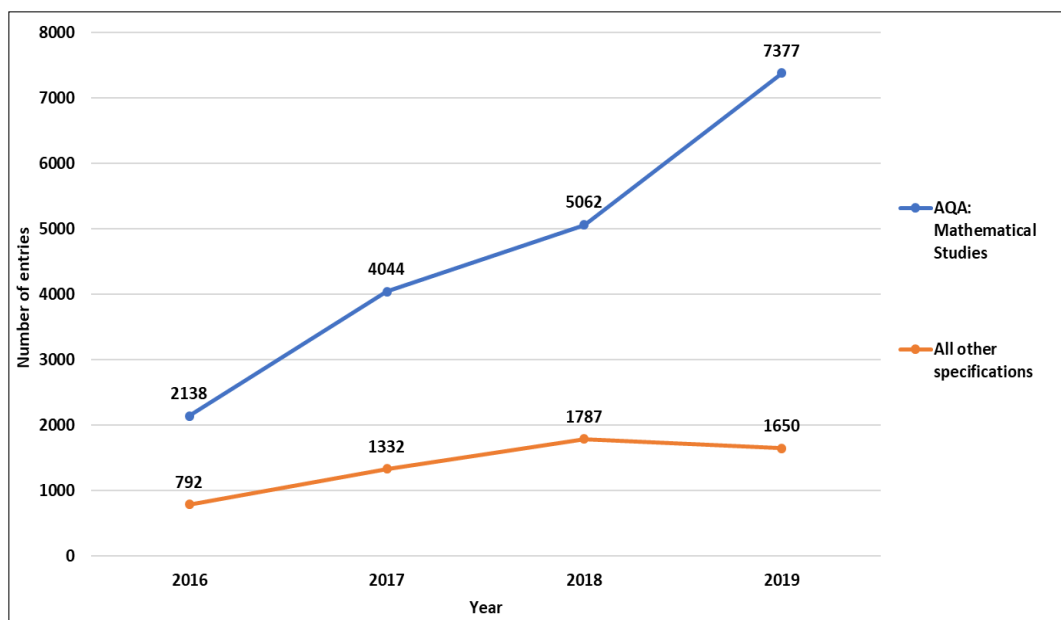


Figure 11: Awarding body entry figures for Core Maths by specification (AQA vs. all other)

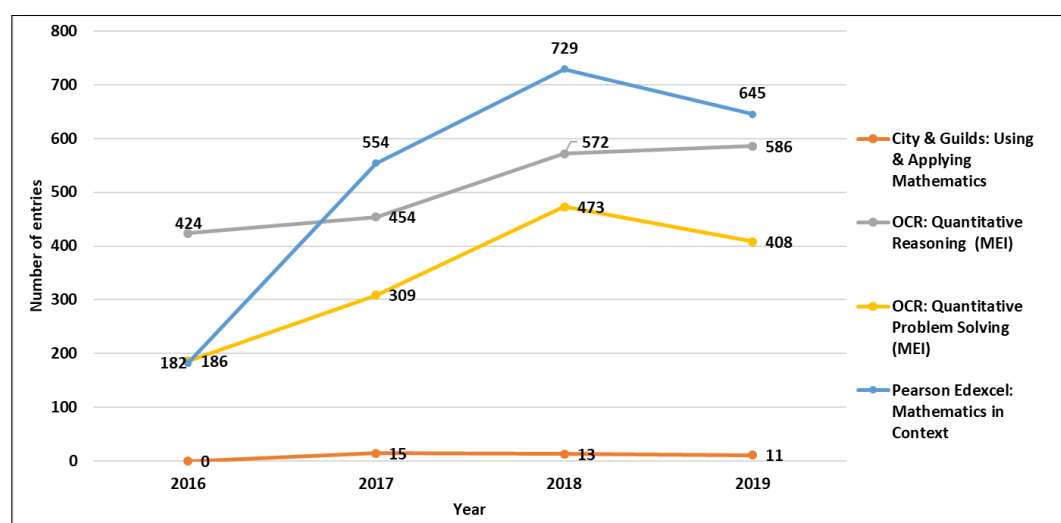


Figure 12: Awarding body entry figures for Core Maths by specification (non-AQA specifications)

The AQA entries are dominated by the Statistical techniques option: NPD data show that 70% of AQA entries were awarded this in 2018, with Critical path and risk analysis at 22%, and Graphical techniques at 8%.

### 4.7.4 Teaching resources

Our evidence shows a general sense of it being difficult, at first, to find suitable resources specifically for CM, and having to create resources from scratch, building them up over time. Many teachers talked about the struggle to find suitable resources for CM, compared to the well-resourced A-level Maths. One CM teacher said specifically that, having taught the course several times, she felt more comfortable, having built up resources and knowing where to go for more.

For some teachers in the Early Adopter and Early Developer centres, it was an explicit part of their role to develop

resources, and money was available for this purpose. The resources were then shared (sometimes rather reluctantly) when training teachers from other schools. Teachers also make their own teaching resources, revision booklets and progress tests, often incorporating current affairs from the internet or adapting old A-level or resources meant for teaching other qualifications. For example, the substitute teacher at Arnold FEC uses HNC/HND resources for the financial aspects of the course, and at Mori SFC a teacher was using textbooks intended for teaching S1, a Statistics unit within A-level. Past and specimen papers were considered to be important, even though some teachers make their own.

In terms of technology used in teaching CM, there was evidence of laptops, iPads and computers being used in classrooms and in dedicated IT spaces outside classrooms, and teachers told us they sometimes used spreadsheets. There was little ambition from teachers or managers to increase the use of technology, as was envisaged in the Smith Report as being a way to enhance and develop the teaching of CM (Smith, 2017).

Evidence suggests a perception that AQA and OCR were ready with CM-related resources more quickly than other examination boards. Teachers state this as one of the main reasons for choosing particular specifications. However, there was little evidence of teachers using dedicated Core Maths textbooks. One teacher said she had seen the Edexcel textbook and did not like the way it was structured. There was limited mention of Edexcel in terms of resourcing. One Head of Maths said she did not think Edexcel had put much effort into developing its Core Maths resources, because it was prioritising GCSE and A-level changes. The Integral website resource produced and maintained by MEI, which is linked with OCR, is highly spoken of and used extensively, even by some centres not using the OCR specification.

Ball's CM teacher has used the AQA website for resources, as has Jones's CM teacher. Teachers talked about finding social media sites where online communities of CM teachers can be found. This has proved to be very important to some teachers who said this was the only source of training or support they had. Other online sources used by teachers include the TES website; CMSP website resources (teachers do say that the links to the CMSP resources have proven problematic since the CMSP web content was transferred to STEM Learning); Teachit; the AQA 'route map' with links to many different sources; STEM Learning website itself; exam board websites; and all manner of other websites, including American ones. By the summer of 2019, one of the CM teachers at Arnold FEC describes an explosion of online resources on Twitter and on YouTube uploaded by individual Core Maths teachers, and since the inception of the AMSP, its provision of online resources has increased noticeably.

#### **4.7.5 Experiences of the differences between A-level Maths and CM**

Teachers, managers and students are all aware of the relative difficulty of A-level and CM. A large proportion of students taking CM in the first year of interviews said they had heard how difficult A-level Maths was, or would have been, saying it might have been too much for them. Many students said they did CM instead, because they were not clever enough, or even good enough, for A-level, and that A-level Maths was 'not for them'.

*"In high school it was really talked up about how it's really difficult, and then when I heard that AS or Core Maths was slightly easier, I was like – that's more manageable."*

(Coates Studio student)

Students believe the pace of A-level Maths is very fast. In comparison, students talked about CM as being "not as stressful" except around exam time, "more manageable", "not as hard" and even "relaxed", compared with the intensity of A-level Maths:

*"It's still a challenge to an extent, but I am not like, worried or anxious about it"*

(Mori SFC student)

The CM teacher at Coates Studio similarly talks about CM lessons being more fun, more enjoyable, and more reasonably paced, compared with A-level lessons which can involve pounding through content, which can be difficult for the students to keep up with, even those with grade 7 at GCSE.

Some students changed from A-level Maths to CM, feeling A-level was too hard, or attaining low grades or failing

their exams at the end of the year. They were generally positive about the change, at least in terms of the lessons and the maths they are learning. CM was commonly thought to be much more useful than A-level Maths. Any negativity they felt about the change of course related to the fact that they would be attaining a different qualification with a completely different status. Some students said they felt that CM was not perceived to have the same high status and value as A-level (see also Mathieson et al., 2020). One student talked about the difference between Core Maths and “actual maths”. Another defined the difference between CM and A-level as being “real-life maths [CM] vs normal maths [A-level]”.

However, student perceptions on completing the course, particularly at Lions, indicate that the negativity around the relationship with A-level Mathematics may be down to the marketing of CM in their institution:

*“it’s marketed at people who aren’t good enough to do A-level Maths, and I think that’s doing it a bit of an injustice, to be honest, because I think it is something that’s practical and useful and something that should be recommended to people who want to know how they can apply maths to real life.”*

(Lions student)

Another Lions student said of CM that it was “always seen as the weaker option to the full A-level Maths, but it’s probably the more useful course, to be honest”.

In an acknowledgement of the status difference between the two qualifications, Heads of Maths and CM teachers commented that some students who take A-level Maths because of its status would be better taking CM for its usefulness. There is also a perception that the two qualifications have different target markets, in contrast to the purpose stated in the CM documentation that any student with a GCSE 4+ can take CM. At Viana SFC, the Head of Maths said that CM was more suitable than A-level Maths for “our” students. He describes how the higher achieving students will be directed towards A-level Maths, if they have the requisite GCSE Maths grade, or to A-level Statistics, so that they have full maths qualifications; it tends, therefore, to be the lower achieving students who are directed towards CM as a support course for other subjects.

Similarly, at Lions, one of the CM teachers says Core Maths is aimed at students not going to red brick universities, but those on the next level down, where they will need some maths in their degree:

*“I think Core Maths is very much aimed at the, sort of second-tier university students, not the ones that are going off to, you know, your Cambridge, your red-bricks, but the, the next level below that that need some maths in their degree, I think that’s where Core Maths fits in, in the syllabus an awful lot.”*

#### 4.7.6 Section summary: key findings

Teachers enjoy teaching CM because it is a clearly distinct qualification from A-level Mathematics (4.7). CM is perceived by students to be less pressurised and less intense than A-level Mathematics (4.7.5).

The deliberately sector-led approach to the rollout of CM resulted in a partial coverage of the country, with those institutions already within networks being, on the whole, the ones who engaged with CM (4.7.1). Training provided by the Maths Hubs or support programmes (CMSP/AMSP) did not necessarily reach teachers who were not part of local networks. It is not unusual for teachers to have embarked on teaching CM without any training at all. Teachers report having had to fend for themselves, including making their own resources in the first couple of years, though resources are now becoming plentiful, especially thanks to online platforms and social media sharing.

CM tends to suffer from a relative lack of status, especially when compared with A-level Mathematics rather than being valued in its own right (4.7.5). This can be due to a perception that CM is for students for whom A-level Mathematics is not appropriate, which in turn can depend on how the institution markets the course, and at whom. The status problem is exacerbated by the fact that CM is half the size of an A-level, which can lead to problems with a student’s package of qualifications, particularly when it comes to applying for higher education.

## 4.8 Core Maths purposes are clearly communicated to students

**A clear statement of purpose will help students make informed decisions, ensuring that they are fully aware of what the qualification offers**

(Core Maths: Technical Guidance)

### 4.8.1 Lack of clarity as to what type of qualification it is

There is confusion around the exact nature of the qualification. Some students describe it as “an AS”:

*“you got an AS in it at the end of the course.”*

(Mumford student)

Even some teachers, such as the CM teacher at Palis, refer to CM as an AS. This could simply be their shorthand for a course which is not the full size of an A-level, and the expression may well disappear in schools and colleges where AS qualifications cease to be taken.

In fact, Palis High School, where the CM teacher refers to CM as an AS, happens to be the only one of our case studies where the course is referred to by the title of the specification:

*“ours is definitely the Maths in Context course... Which is a great title, isn't it, 'cause that tells you what it is!” (laughs)*

(Head of Maths, Palis)

### 4.8.2 Examples of marketing

The case study schools and colleges used various strategies to raise awareness about Core Maths and its benefits. Strategies and messages employed to market this new course are connected to the target group in each place.

#### 4.8.2.1 Reaching students in their own school or college

In several schools and colleges, displays in classrooms raise the profile of Core Maths. Lions also has a Core Maths noticeboard in the maths corridor near the sixth form centre.

Teachers and managers use GCSE lessons, assemblies, and pre-16 interviews when students are considering their options, as opportunities to encourage their students to consider taking post-16 maths. Specimen lessons are taught to KS4 classes by the CM teachers in schools, and even by visitors from the Maths Hub.

SFCs and FECs have the problem of not necessarily having direct access to, or a relationship with, KS4 students. In 11-16 schools, assisting students with post-16 decision-making is particularly challenging, since students may progress to a multitude of post-16 destinations, with which school staff may not be familiar.

Peers recommend Core Maths to friends. At Jones FEC, the Curriculum Manager for Maths also wonders about offering taster lessons of Core Maths to the Maths GCSE resitters, to entice them to study it the following year if they reach the requisite grade.

#### 4.8.2.2 Reaching students when visiting sixth forms at open events

All institutions have open days and/or open evenings, and most say they publicise Core Maths on those occasions to students interested in maths and also to those hoping to take numerate or mathematical subjects. School sixth forms

have open events, to which their own students and students from other schools are invited. At Mori SFC, the CM teacher and Head of Department both say that, for those students who express an interest in studying maths, they only publicise A-level Maths; students who then are not eligible to access A-level Maths on arrival at the college are given the option of Core Maths.

#### **4.8.2.3 Recruiting other staff to act as ambassadors and recruiters**

Where the growth of CM is successful, staff other than the maths department are aware of, and promote, CM and its potential to support subjects more widely. The profile of Core Maths is high at Lions, possibly because it was one of the Early Adopter schools, and Core Maths is more embedded in the school's curriculum offer than it is elsewhere. Ball's Head of Maths gives to the Head of Sixth Form the names of students to target at their pre-16 interviews. Institutional strategies are essential if Core Maths is to grow; making sure staff across the institution are on board with the strategy is also crucial.

Within our case studies, there are good examples of individuals being particularly influential in the growth and flourishing of Core Maths within their institution or local area. Indeed, the presence of such a supportive individual within the management team can be the difference between success and failure in an institution's introduction of CM.

### ***4.8.3 How Core Maths is marketed to students***

Core Maths is marketed to students as having a number of benefits.

#### **4.8.3.1 Maths goes with other subjects**

The most widely used strategy for promoting Core Maths is to emphasise that, as Coates Studio's Head of Maths says, "it runs along quite nicely with other options". The Core Maths teachers at Lions say that at open evenings they talk particularly about how Core Maths supports other subjects. Teachers at Ball, Arnold FEC and Dickenstein SFC all say they attempt to illustrate to students how valuable maths is, if seen in the light of how it might help other subjects. The Head of Maths at Coates Studio and the Core Maths teacher at Viana SFC describe liaising with staff of other subjects to find out how Core Maths could help their courses. Viana's deliberate strategy is to promote Core Maths for the purpose of supporting other curriculum subjects; indeed, the Head of Maths says they have no other justification for offering Core Maths.

Some students will accept that this is a good reason for doing Core Maths. Others say that they do not need to take Core Maths precisely because they are already covering the necessary maths in their other subject. Engineering students on the triple BTEC Engineering course are the most likely, within our case studies, to have this opinion, though in fact the maths content and the approach to applying the maths are very different between the two.

At Jones FEC, Core Maths is specifically targeted to support IT students. These students are made aware that it is the request of the accrediting university at Level 4 that students continue with their maths between GCSE and moving on to a degree programme. The Curriculum Manager and teachers at Jones have considered widening the scope of Core Maths to more vocational areas and even offering it as an enrichment to any student.

#### **4.8.3.2 Maths is useful for its own sake**

Many staff speak about ways of persuading students that Core Maths is a course worth taking for its own sake. There is a view that it is simply good for students to be continuing maths post-16, that CM offers a different experience to, and a progression from, GCSE. Some teachers do believe that post-16 maths may even become compulsory in the future, so students who choose to do Core Maths now will have an advantage over others. Some staff focus on the ease of doing Core Maths: the Head of Maths at Lions says that those who did well at GCSE can score quite highly in Core Maths without much demand on their time; Ball's Head of Maths has a policy of not giving homework for Core Maths, so that the students complete their work within lessons, hoping that more students will be persuaded to enrol.

### 4.8.3.3 Everyone should do financial maths and maths for life

Our evidence shows Core Maths being marketed as a version of maths with real-life applications. The focus on real-life maths, maths that students will encounter in their daily lives, maths which is found in newspapers and media reports, which is useful and engaging, is widely appreciated by students and staff alike in the case studies. In particular, the financial maths and maths for life included in CM are universally applauded.

### 4.8.3.4 The Core Maths course is a useful stop gap

There are also more practical reasons for taking CM. One is to use the course to plug a year-long gap, if a student is giving up a two-year course after only one year. As well as addressing the required Guided Learning Hours, the addition of CM to a study programme also has the purpose of gaining more UCAS points.

## 4.8.4 *Section summary: key findings*

Schools and colleges vary in their marketing strategies and messages (4.8.2). School sixth form staff in 11-18 and 14-18 schools are able to inform pre-16 students about CM and its benefits. Staff in 11-16 schools are less likely to be able to advise about options available to their students going into new institutions. Colleges (FECs and SFCs) hold open events at which they promote their courses.

The marketing messages to students of the benefits of doing CM do not necessarily match with their actual and eventual experiences; for example, students told that CM will help their HE applications may find that this is not the case (4.8).

There is also confusion around the nature of the qualification, which is sometimes referred to as an AS.

## 4.9 Core Maths is dependent on HE demand

### Demand from higher education is critical to the success of Core Maths

(Core Maths: Technical Guidance)

#### 4.9.1 HE signalling

Post-16 education has, since the introduction of A-levels after the Second World War (Phillips and Pound, 2003), been mainly a province for university entrance preparation. Post-16 curricula have largely been designed with this in mind, and signalling from universities directly influences the choices made within the post-16 sector. Much discourse within the post-16 sector, therefore, centres around the exchange value of qualifications, and post-16 institutions are largely providing courses which lead to qualifications acceptable as part of the admission process to universities.<sup>44</sup> The Head of Maths at Ball says specifically, “if they’re [Universities] not asking for it, why are we doing it?” Signalling from HE about CM is a major factor in our data, and the response of universities to CM is a story still unfolding.

From interviews with Q-Step representatives from a number of UK universities, AMSP regional and national leads, UCAS and awarding body representatives, and higher education admissions staff, desk research exploring university websites, and our three rounds of qualitative fieldwork in our case studies, we have formed a picture of a sector which is unsure as yet how to respond to Core Maths. Whilst the HE sector was responsible for building up pressure around the provision of opportunities for students to study maths other than A-level Maths in the post-16 phase, the response of HE to the introduction of Core Maths qualifications has not been as positive as teachers and students - and many in the maths education community - would have hoped.

At the time of writing (July 2020), three UK universities – Bath, Sheffield and York – have published alternative offers (the reduction of one grade) for students applying to certain specified courses, based on their attainment of a grade A or B in Core Maths. This is a positive step. The AMSP is working assiduously with HE, including approaching central university admissions staff and admissions tutors for courses, departments and faculties, to familiarise them with CM and the benefits it can bring for students and for the universities in their turn. However, AMSP leads whom we interviewed expressed frustration and disappointment that universities on the whole are not even specifying that Core Maths would be an advantage, let alone signalling that they might look favourably on students with Core Maths or include it in their offers.

Policy documents and academic reports have regularly been produced describing the impact on HE of longstanding historical low post-16 maths participation in England and the UK more broadly. Some of the most influential were produced by ACME (2011; 2012) and the HEA (Hodgen et al., 2014), who, along with the government,<sup>45</sup> expressed two substantive goals: firstly, for HE to improve its signalling of the importance of continued mathematics study post-16, both in a broad sense and in terms of specific maths skills relating to particular disciplines; and, secondly, to improve HE’s awareness of the Core Maths qualifications as a means by which students may have been developing their mathematics skills prior to arriving at university. We discussed the support which CM can give to students prior to arriving at university in an earlier sub-section of this report (4.4.4). In the current section, we address the extent to which our data show that these goals set for HE around the time of the inception of CM, in terms of their awareness of CM and their signalling of its worth, are perceived to have been met.

Professor Paul Glaister of the University of Reading has been instrumental in providing information about Core Maths to as many stakeholders as possible. As a consultant to the Core Maths Support Programme (CMSP), a member of the joint DfE/CMSP HE Task Group, a member of the A level Content Advisory Board (ALCAB) for AS/A levels in Mathematics and Further Mathematics, and a higher education external expert adviser to The Office of Qualifications and Examinations Regulation (Ofqual), he acted as an ambassador (and continues to advocate) for Core Maths on

<sup>44</sup> See also the recent Royal Society report Signalling the value of studying mathematics post-16 <https://royalsociety.org/topics-policy/education-skills/mathematics-education/royal-society-acme/signalling/>.

<sup>45</sup> <https://www.stem.org.uk/resources/elibrary/resource/416707/minister%E2%80%99s-letter#&gid=undefined&pid=1>

behalf of the DfE. An early Ministerial Communication to HEIs about Core Maths<sup>46</sup> was accompanied by his briefing paper and an offer to visit.<sup>47</sup>

Professor Glaister has been successful in securing the agreement of universities to make clear, through a statement, their support for Core Maths. A document<sup>48</sup> collecting all these statements is available at the STEM Centre website.<sup>49</sup> However, for schools, and for students researching HE courses and providers, the list is not overly accessible. Nor are the individual statements which are posted on institutions' websites. Students searching for a particular subject or discipline navigate to the relevant pages, and are unlikely to find a Core Maths statement which is placed in a neutral location, or on a page relating to curriculum reform. Typing 'Core Maths' into the search bar of the University of Leeds website, for example, produces 282 responses, and the relevant entry is on the fourth page.<sup>50</sup> A student searching for the entry requirement for Psychology at Leeds will come to the appropriate page of the university website,<sup>51</sup> and find that they need GCSE Maths grade 5 (B). A statement about the EPQ clarifies that, "The Extended Project is welcomed but is not included as part of our offer." No statement is made about Core Maths. Only if the student clicks on the 'accepted qualifications' link will they go to the central university page where it says that "We will accept Level 3 Core Maths if you have achieved a grade C/4 in GCSE Maths, but you need a higher grade for your chosen course."<sup>52</sup>

At our case study institutions, staff and management highlighted the tension between an understanding or belief that universities are looking for students with post-16 maths qualifications, including Core Maths, and the realisation that, in practice, higher education institutions do not afford specific recognition to Core Maths in their literature or web-based publicity. It is more likely that admission to a university course will specify a particular grade at GCSE Maths. We discovered this at the time of our first fieldwork in autumn 2017, and students were still telling us this at the latest fieldwork visits in summer 2019. Institutions, already stretched in terms of staffing, were providing extra sessions for those students who needed to retake their GCSE, not because of funding conditions, but because their HE course of choice required a higher GCSE grade than the one they already had, including wanting to improve from a 5 to a 6. At the time of our third fieldwork visit, in summer 2019, students were still being asked for a higher GCSE grade in preference to any grade in CM. One Dickenstein student, for example, took CM, achieved a grade D, and was told by her chosen university course admissions tutor that this would not be accepted; the student had to set about retaking her GCSE to improve her grade from 5 to 6.

In summer 2019, one Viana SFC student was doing her three A-levels, Core Maths, and a GCSE Maths resit, because Manchester University required a Grade 6 to make her an offer for Audiology and would not accept Core Maths in lieu. Here is their statement on CM:

**The University welcomes and recognises the value of Level 3 core mathematics qualifications (e.g. AQA Certificate in Mathematical Studies). Core Mathematics is not a compulsory element of post-16 study and as a result we will not normally include it in the conditions of any offer made to the student. However, if a student chooses to undertake a core mathematics qualification this may be taken into account when we consider their application, particularly for certain non-science courses with a distinct mathematical or statistical element. We advise students to contact the academic School, who will clarify whether their specific portfolio of qualifications is acceptable for entry on to their chosen course.**

In this student's case, CM was not acceptable. At least she was being given the chance to resit her GCSE, to see if she could achieve a higher grade than her previous grade 4. This was on her offer document. The student was frustrated, however, to be sitting GCSE and CM at the same time, especially with the amount of work she already had to do with her three A-levels, and this led to her feeling resentful towards the college which persuaded her to take CM.

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46 [http://www.personal.reading.ac.uk/~smsglais/Communication\\_to\\_vice\\_chancellors.pdf](http://www.personal.reading.ac.uk/~smsglais/Communication_to_vice_chancellors.pdf)

47 [http://www.personal.reading.ac.uk/~smsglais/briefing\\_paper\\_for\\_universities\\_on\\_core\\_maths.pdf](http://www.personal.reading.ac.uk/~smsglais/briefing_paper_for_universities_on_core_maths.pdf)

48 [http://www.personal.reading.ac.uk/~smsglais/University\\_Statements\\_on\\_Core\\_Maths.pdf](http://www.personal.reading.ac.uk/~smsglais/University_Statements_on_Core_Maths.pdf)

49 <https://www.stem.org.uk/resources/elibrary/resource/417716/university-endorsement-statements>

50 [https://www.leeds.ac.uk/site/scripts/search\\_results.php?q=Core+Maths&cid=130111&cname=Main+index&searchOption=searchSite&page=4](https://www.leeds.ac.uk/site/scripts/search_results.php?q=Core+Maths&cid=130111&cname=Main+index&searchOption=searchSite&page=4)

51 <https://courses.leeds.ac.uk/3670/psychology-bsc#section3>

52 [http://www.leeds.ac.uk/info/128005/applying/31/accepted\\_qualifications](http://www.leeds.ac.uk/info/128005/applying/31/accepted_qualifications)

Another Viana SFC student was rejected from the University of Liverpool, where she had applied to study Psychology, despite her studying Core Maths; she was told she needed a grade 5, as opposed to her grade 4, in GCSE Maths. CM is not mentioned on the Psychology page, and here is the generic statement on the University of Liverpool website:

**The University recognises the value of the Core Maths qualification to support the development of mathematical skills. While the University will not include Core Maths in our entry requirements, we welcome the additional skills it will give to students. We will not accept Core Maths in lieu of AS/A level Maths or equivalent qualifications where Mathematics is a subject requirement.**

The student was upset. She knew that maths was important, but had believed that studying CM would trump her GCSE grade 4.

At the time of the first fieldwork visit, in autumn 2017, school/college staff were aware of no evidence of a student having Core Maths included in the admission criteria to any course, or even that Core Maths was mentioned as a helpful course or a course which could supplant GCSE Maths in that admission process. There is, at each fieldwork visit, some optimism about the presence of CM on an application creating a good impression for admissions tutors considering whether to make students an offer, and a theory that a student with CM might be preferred over a student without CM, all other things being equal, because of the continued study of maths; but it is not possible to know whether Core Maths was helping students gain offers. One student hazarded a guess:

*“Um, [my offer is] an unconditional, but the thing is, the reason I’ve got it, I know, is because of Core Maths, otherwise I wouldn’t have got it because my friend, he’s doing Applied Sciences as well but he’s not doing Core Maths, and he didn’t get unconditional for that”*

(Dickenstein SFC student)

Students beginning their CM course in autumn 2017 said they felt (they had been told by their teachers) that having CM would be good for showing that they had a qualification in maths when they applied to university. Some students referred to CM as an AS, implying that CM carried the same currency. Some students said they were taking CM for the UCAS points; other said CM was not worth many UCAS points and therefore it would be better to concentrate on their other subjects, especially if they were A-levels. At Viana SFC, where students had to take CM if they had gained grade 4 at GCSE Maths, students were generally of the opinion that that CM was not good for applications for universities or apprenticeships. Without an offer that is based on UCAS points, this appears to be largely true. One Donaldson student who said she had enjoyed maths all her life, and who began Core Maths at the start of year 12, changed to EPQ because she discovered it would be more helpful as an extra qualification.

During the course of this study, the generally weak signalling from HE as to the value of Core Maths has significantly affected the withdrawal rate of students from the CM course. Students may enrol on Core Maths by choice or by being directed to it; when they discover that it will not count as a grade, or even by being recognised explicitly by the course and institution to which they are applying, they withdraw from the course, saying they would rather spend their time focusing on their main study programme, which does count. Core Maths is not their priority. This then causes a retention problem, and ultimately threatens the survival of CM within the post-16 institution.

At Dickenstein SFC, the Head of Maths says she thinks “the solutions have to come from the universities... And they have to do something like Bath are doing.” At Ball, the Head of Maths said at each visit that HE’s attitude was key. It was her view that CM was introduced in the first place because universities wanted students to have some maths in their portfolio, but that the incentive to offer it has diminished, as she explains here at the third visit:

*“I think where they went wrong with Core Maths was, at first, it was sold that the universities were going to insist on people having it if they were going to do, like, a maths-based degree. And then they decided to take that away. And that’s where you lost all the emphasis for Core Maths.”*

At the second visit, she had told us that “because it’s only seen, I suppose, as half an A-level, because it’s not given the status by universities, it’s not a crowd-puller”, the course would only attract small numbers and therefore risk not

running at all. Being of the firm view that everyone should be doing CM, this is a source of great disappointment to her, as was the eventual withdrawal of the course because of small numbers.

There is something of a chicken and egg situation here. From schools and colleges, we hear that until and unless HE increases the pull factor on CM, schools and colleges will not offer it in sufficient numbers. Yet we hear from HE that there are not yet sufficient numbers of students presenting CM as part of their package to consider modifying their admissions or offers criteria. A new qualification takes time to gain traction, as the CM teacher at Palis reminded us. We learned through speaking to stakeholders that the process of decision-making in HEIs can be slow, and any change in admissions procedures, including the shaping of an alternative or dual offer, can take years to proceed through the relevant channels and stages to a point where it takes effect. Compiling a business case involves gathering data, potentially over a number of years (the life cycle of a student between application, enrolment and graduation), the exploration of contextual information, competitor information and sector benchmarks. Specifications of Level 3 qualifications need to be examined carefully to see what is being taught, before departments decide to declare that a particular Core Maths grade is more desirable than a grade 5 or 6 at GCSE Maths. Consideration has to be given to reputation and potential risk. Currently, not enough students take Core Maths, and not enough have gone through the university system, for data to become sufficiently powerful and persuasive to bring about policy change in the near future. We have also learned that the different departments and/or faculties within a university can choose to opt into or out of university-wide decisions, if they feel those moves are not appropriate for them at that time.

Several teachers in our case study institutions recalled the beginnings of the EPQ, when few students took up that qualification, and remarked on how it has grown, in no small part as a result of universities making alternative offers which include the EPQ. Students now see the EPQ but not Core Maths as relevant and valued, and their perception is backed up by HE's current attitudes, as the Head of Sixth Form at Ball explains:

*“But for the student as well the EPQ is really good, because what it does is it, it develops the independent skills, they have to do a presentation... So by the time they get to university, they've done all that stuff and they can see how that would be relevant, and I think, two problems, I think, the student doesn't see the relevance of the Core Maths, but because the universities aren't showing the students the relevance of the Core Maths, it's not happening.”*

It is notable that, by the time of the third fieldwork visit, a slight shift was perceptible in student and staff views. For example, a Coates Studio student applying to do Architecture says that, in two interviews, when he has mentioned Core Maths, the admissions tutors have been interested:

*“they've been quite intrigued by it because architecture is a subject that requires design elements and maths as well. Erm, so... they just thought of it as an added extra, which was interesting.”*

A Mumford student who had an offer from Sheffield to do Molecular Biology was asked about Core Maths in her interview. She said she told them it had helped develop skills in Biology. A Viana SFC student had an offer from Manchester for Psychology, which normally requires a GCSE grade 6; he rang them and persuaded them to accept CM instead of his grade 5 at GCSE. At Dickenstein SFC, four students told us in summer 2019 that they had been advised by a number of universities, at either an open day or an interview, to take some maths alongside their Applied Science, when applying for Pharmacy and for Advanced Manufacturing, to give them the edge over other students.

In addition, by summer 2019, CM's value in terms of UCAS points was more prominent in interviews. Students were also more likely at this point to say that, having completed this extra qualification, they could show on their CV that they had used their time during post-16 study wisely, by taking this extra maths course.

The Principal of Rousseau UTC had reinstated CM after a year of not offering it, and said explicitly that he sensed a shift in attitudes from HE, in the direction of looking at students' breadth of study. He believed that some universities are accepting students with whatever qualifications they come with, which is especially true of the universities which are admitting students on a tariff-based offer rather than specific grades in particular subjects. Having expressed his initial concern in 2017 about whether universities would accept certain qualifications, two years later, in 2019, he

tells us he is becoming less anxious about being certain that all courses and programmes they offer will be accepted by universities:

*"I cannot reiterate enough how I am becoming so much more blasé, and maybe that's the wrong word, but I'm being, I'm so much more relaxed about the courses that we offer to those students that want to go to university. Not a specific type of university, but to university. Because I genuinely feel that every programme that we have offered where they have wanted to go to university, nothing that we have offered has been an impediment to them going... I was so worried at the beginning with Core Maths and with BTEC. What happens if we take these kids down a route of two years and we have wrecked their chances because we've said, 'oh, yeah, this is good'? And then university says, you can't go... The message that we've had is very much, yeah, we'll take your single BTEC in that, we'll take your single BTEC in that, we'll take your single BTEC in that and your Core Maths in that, and we'll take your English retake and we'll take your EPQ... For the first time ever, the other day, I almost, I felt this was really surprising, somebody had been offered, in this school, a semi-conditional offer on a triple BTEC to go to [X University] to study sciences, and I was surprised. [X University] had offered a triple-BTEC option to get straight in to do sciences. And, I, I was, wow, okay. So, it's changing."*

This Principal believes that the University of Bath alternative offer is a good one, dropping a grade for CM to show that a student has worked a bit harder, to secure an extra qualification and a broader post-16 base; but he also comments that this is a low-risk strategy to employ, in disciplines where A-level Maths is not required.

#### 4.9.2 Section summary: key findings

Signalling from higher education institutions of the value of CM for studying at university remains weak (4.9.1). Whilst there are UCAS points for CM, the qualification itself, achieved at any grade, does not usually carry exchange value. This is a significant source of frustration amongst CM teachers and CM students.

There are tentative signs of movement, albeit gradual and piecemeal, in the direction of more signalling of the value of CM by a number of HE institutions. The Universities of Bath, Sheffield and York have published explicit alternative offers based on attainment in CM, and other individual university admissions tutors seem to be beginning to show more interest in the qualification.

Retention on CM is negatively affected when students who believe that having a CM qualification, in addition to their main programme of three A-levels or equivalent, will enhance their university application discover that it may not (4.9.1). Retention problems can in turn cause institutions to withdraw their CM provision. Teachers say that without the pull factor from HE, institutions and students will not take up CM in the desired numbers.

Higher education institutions are more likely to specify a particular GCSE grade in Maths than to take notice of achievement in CM (4.9.1). This can lead to overstretching of post-16 resources, as students who have already achieved grade 4 or higher are retaking GCSE Mathematics to secure a higher grade for university entry.

## 5 Case study vignettes: illustrations of CM implementation

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We conclude this report with a series of case study narratives. Our intention here is to paint a rich picture of the varying implementation of Core Maths across this set of institutions.

### 5.1 Introduction

There follows a series of thirteen vignettes, each providing a narrative account summarising data generated in the thirteen institutions which participated in the study. A list of institutions, with details about their type, their location in England, the awarding body they use for CM, and the duration of their CM course, was given in the Methodology section of this report (Table 1).

Each vignette begins with a diagram summarising the fieldwork carried out in the institution. It gives details about the number and dates of fieldwork visits to the institution, and, at each visit, the groups of people – Core Maths teachers, senior managers, students – who were interviewed. Roles carry different titles in different institutions. For current purposes, ‘Senior leader’ is defined as someone who has leadership or management responsibility for curriculum, which is not specifically or solely linked to maths (this could be a Principal, or Head of Faculty or Head of Sixth Form); ‘Maths manager’ is a manager or leader who has direct responsibility for maths (e.g. Head of Maths, or in some cases Head of Department). Some Heads of Maths do not teach CM, whereas some do; the distinction is preserved between CM teacher and Head of Maths, because of the extra responsibility of Head of Maths.

The vignettes continue with some demographic detail and background to the geographical location of the case study institution, but we have taken care to blur some of this detail in order to preserve the anonymity of the institutions and individuals involved. To provide this background information, individual school and college websites have been consulted, and broader demographic, regional and institutional data have been taken from the most recent available statistics from local authority websites and the following government websites:

- Find an Ofsted inspection report at <https://www.gov.uk/find-ofsted-inspection-report>
- Find and compare schools in England at <https://www.gov.uk/school-performance-tables>

The vignettes enable us to present the characteristics and particular successes and/or challenges faced in each school or college when it comes to developing and sustaining CM provision. The portraits illustrate how the themes as detailed in the Main findings section of the report above play out in different contexts. Whilst many issues are common across institutions, the nuance and nature of how each manifests itself in any particular institution are contingent and therefore varied. The vignettes provide a summary of the diversity we have uncovered within institutional responses to the Core Maths policy initiative, and are intended to enhance policymakers’ and stakeholders’ understanding of the complexity of institutional response to a new post-16 mathematics curriculum offer.

These narratives enable us to document changes in CM provision which took place over time in each of the institutions (2017 to 2019 in most cases). We can also elucidate on particular methodological challenges we faced in specific schools or colleges.

## 5.2 Case studies at a glance

### Arnold FEC

CM first taught in 2015. High turnover of staff. Successfully retained the course despite challenges with staffing and results. Advocates within the college support it because it is relevant to their students. Students enthusiastic about CM as opportunity to continue studying maths; CM seen in a package with study programme so retention less of a problem. Any student can take it but students who have done well at GCSE are targeted individually at enrolment.

### Ball High School

Early Developer. CM first taught in 2015. Sixth form numbers are reducing. Once an academically successful sixth form, now competition from nearby post-16 colleges is strong and small classes of any kind are unfeasible. Allowing students to opt in has resulted in tiny classes (1 and 2 students) which are unsustainable. Head of Maths and CM teachers are frustrated at lack of take up and lack of support from management. Belief that all students should take CM. Year 12 cohort from 2017-18 go through to second year, but no Year 12 cohort formed in 2018-19. Course withdrawn.

### Bismut Academy

CM first taught in 2015. The CM teacher learned of CM from the lead school in the academy trust, which is also a teaching school. Treated as routine for students to take CM as one of their three options in first year post-16. Changed from two-year to one-year course following retention difficulties. This case study only took part in the first round of fieldwork.

### Coates Studio

CM first taught in 2016. Linked with the Scripting and Programming course and offered as part of the TechBacc. Classes diminishing in size over the course of the project (two students took the course in 2018-19), and the future of the course looked uncertain at our final visit (2019), despite staff valuing the course and the Principal being supportive.

### Dickenstein SFC

CM first taught in 2016 as a replacement for Use of Maths A-level. Senior management support for a maths course other than A-level. CM linked to Applied Science in 2017-18 to increase numbers; disappointing dropout (roughly two-thirds) by the end of the year, and management reduced provision subsequently. Numbers dwindled in following years.

### Donaldson High School

Early Developer. CM first taught in 2015. Sixth form is part of a larger consortium. Principal likes having a mathematics qualification at the Donaldson campus; A-level Mathematics is taught at one of the other schools. Students opt in, and CM is taught in enrichment period over two years. Teachers are some of the most constructivist in the project; lessons are very free. Dropout high between year 1 and year 2; no Year 12 cohort formed in 2018-19, and course withdrawn altogether the following year.

### Jones FEC

CM first taught in 2015. Uniquely amongst case studies, Jones uses CM to support continuing engagement with mathematics for IT students who may go on to undergraduate courses in the college, to improve Level 4 maths module marks at the behest of the accrediting university. Welcomed the AMP for its potential to increase numbers, but has not actually received any AMP funding. IT students, who often only just achieved their GCSE Maths grade 4, resentful at being directed to study CM.

### Lions Academy

Early Adopter. Teaching school and lead school in MAT which also includes Bismut Academy. CM first taught in 2014. Now well established and familiar to staff beyond the maths department. Treated as routine for students to take CM as one of their three options in first year post-16. Sense of the lower status of CM from students in relation to A-level Maths is particularly noticeable. Students value CM qualification for its usefulness and relevance, and believe comparisons with A-level Maths do not do it justice.

### Mori SFC

CM first taught in 2016 as replacement for Use of Maths A-level. Sixth form centre within much larger post-16 college across region. Main recruitment to CM is of students who want to study maths but who cannot access A-level Maths, or transferring from A-level Maths into CM partway through. Teacher approaches CM as he does A-level Maths, with transmissionist pedagogy. He believes there is not enough content for a two-year course. Positive messages from management about Core Maths's place in college; however, CM abruptly dropped in 2018 after a redundancy results in lack of staffing capacity.

### Mumford School

CM first taught in 2015. Maintaining breadth of study important to management. Offered to any student in enrichment block but then it competes with extra-curricular activities. Teachers very positive about CM. One says it has changed his wider approach to teaching. Numbers on the course are not high; dropout between year 1 and year 2 is a problem. Teachers were not part of any network and not in contact with the local Maths Hub at the start of the study; a year later they were benefiting from such contacts. No CM group was formed in 2018 due to low interest. Despite positive attitudes from teachers and management, the future of CM at Mumford was not promising.

### Palis High School

CM first taught in 2015. Head of Maths wanted something to offer to the students rejected from A-level Maths each year. Students and parents here particularly appreciate the exchange value of Maths A-level as they are often focused on business or finance careers. Students are not keen to take on an extra course, though, and CM numbers are not high. Status problem of CM compared to A-level Maths is pronounced: hierarchy is apparent in the regular description of “dropping down” into CM from A-level. Palis only took part in the first two rounds of fieldwork.

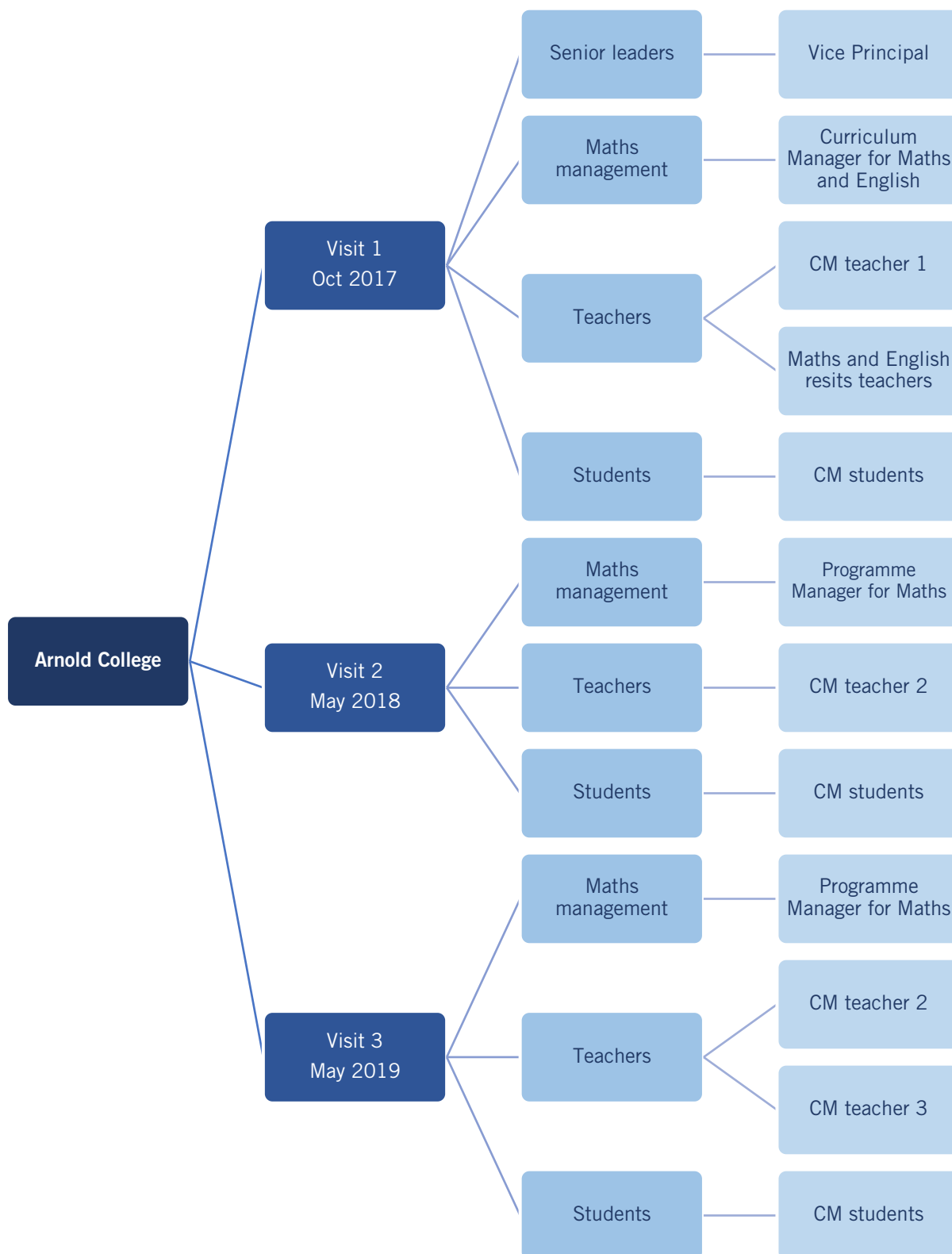
### Rousseau UTC

CM first taught in 2015. Course quickly dropped, due to retention problems between year 1 and year 2 leading to small group size, and poor results. However, the Principal decided, after two years of not forming a new CM group, to reintroduce it to allow students to continue studying maths between GCSE and leaving school to whatever the destination. Interesting take on local employment opportunities which require A-level Maths: the view at the school is that Core Maths would support students in those engineering apprenticeships, and A-level Maths is unnecessary.

### Viana SFC

Early Developer. CM first taught in 2015. Head of Maths very keen to offer every student a maths option: Viana offers CM plus A-levels in Maths, Further Maths and Statistics. Recruitment to CM partially on the basis of opting in but mostly by enrolling students automatically if they have not already achieved GCSE Maths access grades required by other subjects like Psychology and Biology. This results in a large cohort, which in 2019 attracted a high level of AMP funding, but some student resentment and dropout, and a cohort of largely maths-resistant and lower ability students.

### 5.3 Arnold Further Education College



Arnold College is in a city in the Midlands of England with a population of roughly 350,000. Deindustrialisation and economic destabilisation in the 1980s led to high unemployment, but the city is now experiencing growth and investment. The working population here is less well qualified than people in the Midlands generally and across England as a whole. Around one in five people lives in one of the 10% most deprived wards in England, and a third of the population are from black and minority ethnic groups.

At the time of our first visit to Arnold FEC, in autumn 2017, a merger had just occurred between it and another college in the city, both of which were graded *Requires improvement* at their last Ofsted inspection in 2016. At the time, staff were working within their own site, but by the second visit staff were crossing the city to work in both. The new college is now the only general further education provider in the city, offering vocational, technical and professional education and training, from entry level to higher education and apprenticeships, to over 7,000 learners, including adults. At the campus we visited, there are around 2,000 learners. The college does not offer A-levels. Many learners (the college refers to students as learners) come to the college following rejection from their own school sixth forms or local sixth form colleges. Most arrive without GCSE Maths grade 4; those who have attained GCSE grade 4 can be reluctant to pursue maths.

There is only a small pool of learners from which to recruit to CM. Five learners took the course in its first year, 2015-16. Numbers have fluctuated: there were 27 learners in two groups in 2017-18; in 2018-19, there were eleven learners at one campus and eight at the other campus. Across the college, around 2,500 learners need to resit English and/or Maths GCSE in addition to their 15-hour study programme, which puts the number of Core Maths learners into perspective. Some go from passing their GCSE resit to taking Core Maths.

Core Maths was brought to the attention of the Curriculum Manager for Maths and English by a former senior manager, who had been an Ofsted inspector and had heard that the government were pushing towards more, potentially all, post-16 students continuing with maths. The Core Maths team actively promote Core Maths, approaching learners early on in their vocational sessions, particularly targeting those who are interested in science, engineering and business, and individuals who have done well in GCSE Maths. They also talk about CM to other staff, in briefings and at other times. Proximity of staff workrooms facilitates conversation with science and business staff. Core Maths is promoted on the basis that it supports other subjects, it can help with applications to HE, if that is the learner's ambition, and offers a way of continuing studying maths beyond GCSE, which is good for the learner's future. Learners are admitted to the course with a grade 4, and many have only taken Foundation GCSE, leaving them with a good deal of content to learn. However, some learners have done a year at a school or sixth form college before coming to Arnold, and the odd one has gone through the first year of A-level Mathematics. Learners pair CM mainly with business qualifications, and some with sciences.

Arnold offers the AQA specification, with Paper 2A (Statistical techniques), since the first teacher, with responsibility for the initial choice, felt data handling would be the most useful option for the learners. The course is taught over one year: as with FE colleges generally, learners do not necessarily follow a two-year programme, with significant numbers staying for three years, or one. Core Maths can be, as the Curriculum Manager says, "bolted onto" any vocational study programme of 15 hours per week. The tutors work together to timetable maths and English as a priority when learners are free. Core Maths has always been given a three-hour session on a Friday morning, and in the second year of delivery a second group was added on a Tuesday morning.

Core Maths was initially taught at the college by two graduate teachers,<sup>53</sup> who were excited by the course, with one of them stating: "for the Core Maths I was like, wow! That's what I wanna learn!" They had a series of training days, the most helpful aspect of which they say was the building of a "kind of community" for sharing and exchanging of resources. Resources on the whole have had to be found or made by the teachers themselves. The current teachers are glad to have seen a burgeoning of online resources, particularly those gathered together by AMSP leads, and are part of a growing Twitter community for CM.<sup>54</sup>

In the first year of teaching, all learners passed Core Maths, with results ranging from A to E. One of the teachers

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<sup>53</sup> The graduate teacher scheme ran from 1998-2013 and enabled unqualified teachers to train whilst working and earning.

<sup>54</sup> One of the most frequently mentioned is @CoreMathsCat, which belongs to Catherine van Saarloos of the AMSP.

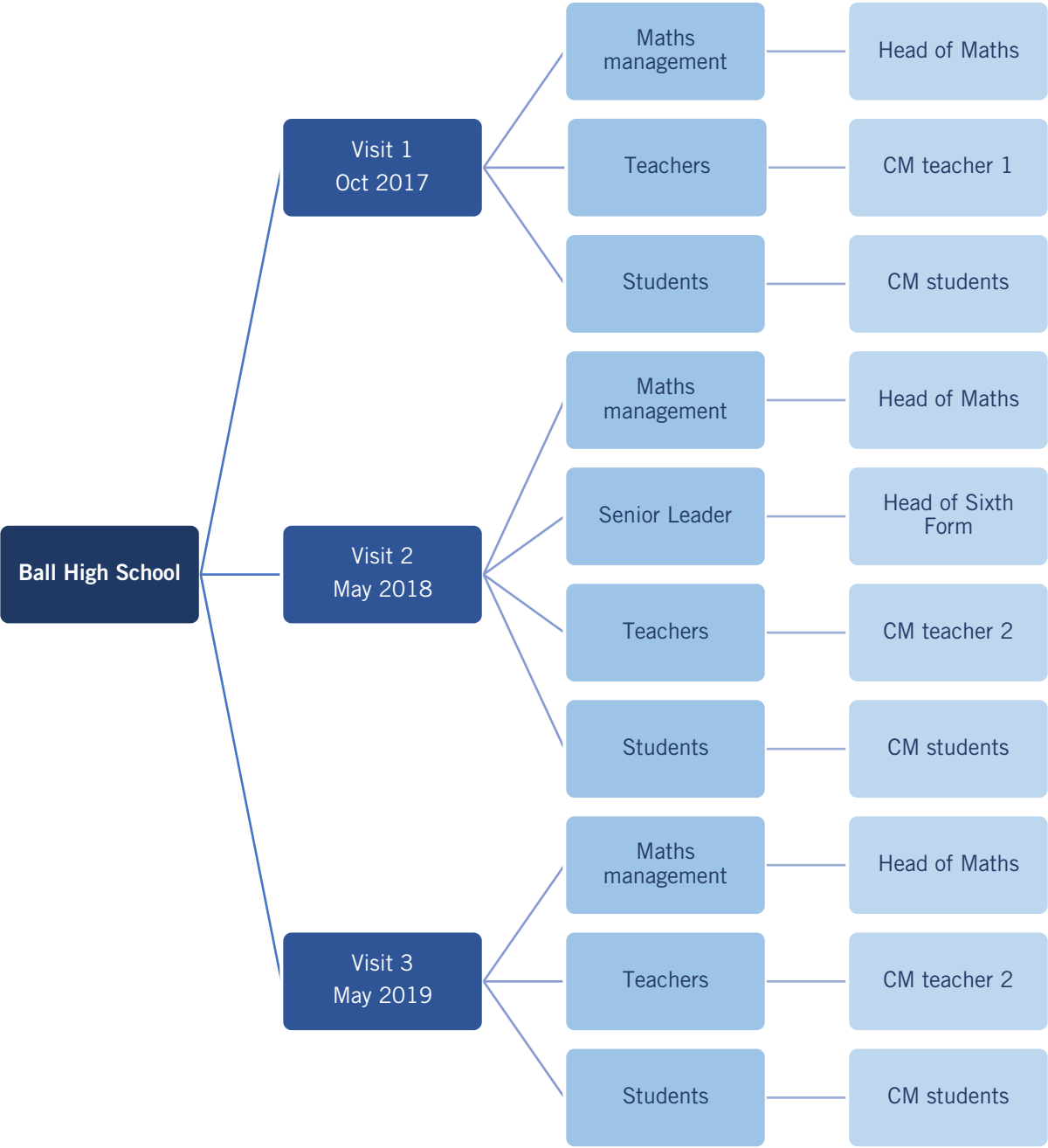
then left, so that at the time fieldwork began, Core Maths was the province of one teacher. His departure through ill health partway through the year left the learners without a teacher for several weeks, which unfortunately led to over half of the learners failing the exam. At the third round of fieldwork, the Curriculum Manager made the notable claim that failing Core Maths had had no impact on any learner's progression, illustrating their perception of how little significance it holds in that respect.

At the first visit, the Curriculum Manager for Maths and English participated in the study. By the second visit, consequent to a reorganisation across the merged college, maths and English roles had been separated out, and a GCSE resit teacher interviewed at the first fieldwork visit had been promoted to be Programme Manager for Maths. He was very keen on Core Maths, and had the ambition of training up several teachers, prompted partly by the previous difficulties caused when the only teacher had left mid-year. At length, a GCSE resit teacher was brought in from the other campus as a substitute, to cover the last few lessons before the exam. He continued to teach Core Maths the following year, joined by another teacher, who was also involved in teacher education at a local university, and whose enthusiasm for Core Maths was clear. She has now left the college. At the time of writing (July 2020), CM teacher 2 is still teaching CM, along with two others including a teacher new to the college, and the Programme Manager for Maths has also left the college.

Core Maths learners at Arnold are, amongst our case studies, the least likely to drop out before completing the course. We tentatively explain this as being due to the way the college positions Core Maths as part of a study programme, rather than as an extra to three other subjects. We suggest that FE learners are less focused on a three-grade outcome to their post-16 programme, facilitating entry to HE, and more likely to consider their programme holistically. HE applications will generally be done on the basis of UCAS points. It is also the case that FE already manages an acceptance of having, for example, a GCSE resit incorporated into a study programme, so it could be that Core Maths is viewed rather similarly, as integral to a programme, not an extra.



5.4 Ball High School



Ball High School, with a total school population of just over a thousand, is a larger than average, but undersubscribed, comprehensive secondary school in the North East of England. In spring 2018, it became an academy as part of a multi-academy trust. One in four pupils receives free school meals, which is well above the national average, and the progress of disadvantaged pupils is below that of others nationally, particularly in English and maths. Absence and persistent absence are ongoing problems. Most pupils are of white British heritage; the proportion of minority ethnic pupils is well below the national average. In 2018, the school's Progress 8 and Attainment 8 scores were well below the national average. At the 2017 Ofsted inspection, the school was rated *Inadequate*. However, the '16-19 programmes' element was graded slightly higher, as *Requires improvement*. Pupils entering the sixth form generally have a good pass in GCSE Maths and English, the resit pass rate is above average, and students make average progress, although attainment in A-levels is below the national average. Some students not completing their post-16 courses leave to begin high quality apprenticeships. In 2017, the sixth form consisted of almost a hundred students, around 50 students enrolling each year to study mainly A-levels, with a handful studying applied general qualifications. Sixth form numbers are falling due to an exodus of students in the direction of new and upgraded post-16 colleges in the local area with which the school struggles to compete. The Head of Maths mentions, for example, brand new gym facilities at the FE college nearby. Smaller numbers mean fewer curriculum options can be offered; several courses have been withdrawn including A-level History. A-level Maths numbers have dropped; Further Maths has been cut. Students have an option to study Further Maths through a local university, supported by the AMSP, but no student has yet done so.

The Head of Maths has been a supporter of alternative qualifications for maths throughout the school, which for many years offered Key Stage 4 pupils Free Standing Maths Qualifications alongside GCSE, so that even pupils who did not attain their C (now 4) at GCSE experienced some success with maths. Responding to an email from the local Maths Hub, she applied for the school to be a CM Early Developer in 2015-16. There were, she says, "lots of meetings" in the year prior to beginning teaching CM, with other Early Developers, and the CMSP and Maths Hub. However, this did not extend to training for other Core Maths teachers, whose only support has been the Head of Maths herself. Recently, the school's shortage of development budget, coupled with prioritisation of the new GCSE and A-level Maths, has meant nobody has had any formal Core Maths training.

The 2017 Ofsted report notes the school's ongoing struggle to recruit maths teachers. We learned at our first visit that an IT teacher was attending night classes in order to convert to teach maths, and that a music teacher was teaching Year 7 maths without any training, although the school wanted to offer her formal training to extend her maths teaching. Due to staff turnover (including mid-year), rather than for any strategic reason, different numbers and combinations of teachers have taught the Core Maths classes. The Core Maths teacher we met at the first visit had been given Core Maths because, according to the Head of Maths, he had "done things outside of education", having been in industry; however, the Head of Maths also explained that CM replaced some lost A-level Mathematics teaching on the teacher's timetable, where numbers were lower than predicted.

The CM teacher told us he had had no training, and was expected to find and/or create resources for the department, as part of his responsibility in the first year teaching Core Maths. By our second visit, this teacher had left. The Head of Maths described how "we still have mortality with our staff...I haven't quite got the steady ship yet that I want. Um, staff leave for various reasons."

The school teaches the AQA specification with paper 2B (Critical path and risk analysis), over two years. The Head of Maths believes AQA was the most popular of the Core Maths qualifications, because it was initially the fastest awarding body to produce resources. However, she also says that they, at Ball, use MEI/OCR online resources, "buying" into the website every year "at a lot of expense...we can't afford the textbooks but there's loads and loads of stuff on there that we can be using."

The Core Maths course is promoted as helping students doing A-levels which involve maths, or those aiming to take a degree which includes some maths, and going some way towards combating the situation where students forget all their maths during their post-16 phase. The Head of Maths is of the opinion that every post-16 student should be offered at least the personal finance aspects of Core Maths, in registration periods if necessary, describing this as "essential". The Core Maths teacher interviewed at the first visit agrees:

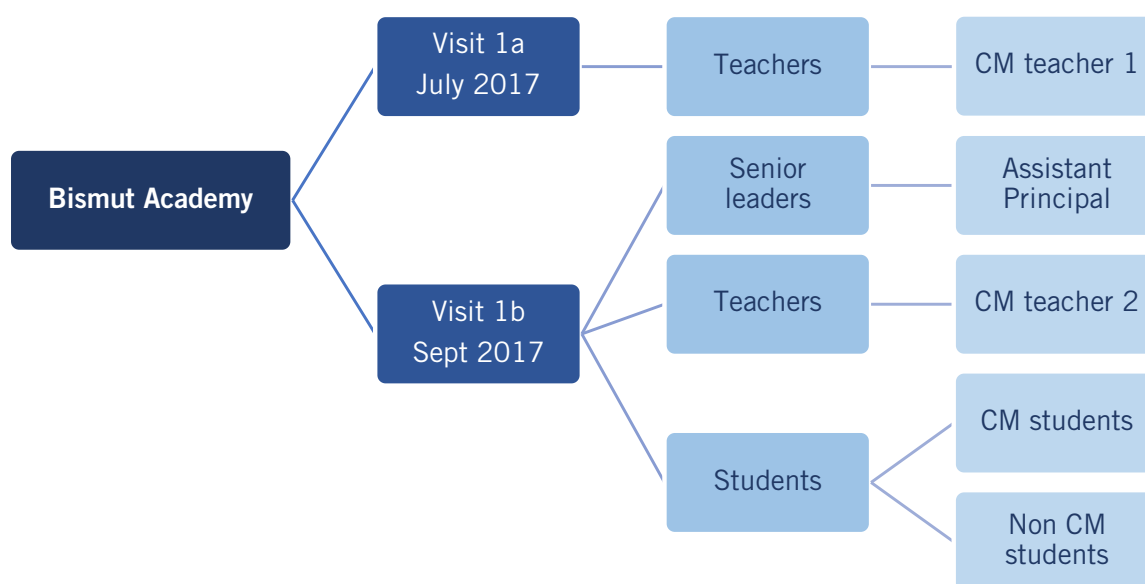
*"I personally love the course, so I keep telling everyone I think it should be taught to all students, if I'm honest, in terms of just being able to appreciate how much a mortgage is gonna cost you and which bank account's good and why not to get a Wonga loan. Things like that. Um, it's all essential maths but we don't have the opportunity to teach it."*

The school has tried different ways of positioning Core Maths within the curriculum offer. Initially offered as an enrichment, blocked against the EPQ and extra-curricular options, it attracted low numbers, and teachers felt three lessons a fortnight were not enough to cover the content. The strategy changed, to offer CM in an option block, in an attempt to give it the same status as two-year A-level and BTEC courses; however, students could see that by opting for the half-sized Core Maths they would forego a full-sized two-year qualification. If taken as a fourth option, the Head of Maths well articulates the view that "...obviously, we're sort of an add-on...That's how I feel the Core Maths is. You know, you choose this, this and this, and if possible, this is the add-on, that you'll get."

The classes have been a mixture of Year 12 and Year 13, some Year 13 students joining after a year of A-level Maths. Five students started Core Maths in 2015, but only three continued to the end of the two-year course, with mixed outcomes. At our first fieldwork visit, two Year 13 students were taking Core Maths, and one Year 12 with an ambition to work in finance, who was tackling Core Maths enthusiastically after taking Foundation GCSE Maths. The two Year 13 students came from top set and second set for GCSE Maths. Retention rates have been poor: students taking it as a fourth option have found they do not need it, in addition to their three main subject grades, if they want to apply to university; those needing to gather more UCAS points are more likely to continue with it as part of their HE application, especially if they drop one of their two-year courses at the end of one year.

The Head of Maths has been a strong advocate for Core Maths, promoting it to students in assemblies, at sixth form open events, and in the higher GCSE Maths sets. She has shown pupils and teachers the university endorsements on the CMSP website. She has argued that students taking science subjects ought to take Core Maths if they are not doing A-level Mathematics. However, decisions around timetabling, the broad sixth form curriculum offer, and individual student guidance interviews around sixth form options are generally closed to the Head of Maths, and her influence only extends so far. Policies and strategies are being disseminated from the central management of the multi-academy trust to which the school now belongs, which she perceives will limit the autonomy of Ball High School and of individual managers. In addition, the Head of Sixth Form explains very clearly her own view that no pressure should be put on any student to take any particular subject. In 2018-19, there was no new Core Maths set in year 12 because not enough students wished to take it. The future looked bleak for Core Maths at the time of our third and final visit in summer 2019. The low take-up by students, and the eventual withdrawal of the course, is and has been a source of sadness and frustration for the Head of Maths.

## 5.5 Bismut Academy



Bismut Academy, situated in a former mining community in the East Midlands, is an average-sized, comprehensive, sponsor-led academy, and part of a multi-academy trust and teaching school alliance, of which Lions Academy (q.v.) is the lead academy. It is well under capacity, with just under a thousand students on roll, around a hundred of whom are part of a joint sixth form consortium with two other local schools. This sixth form is housed in a newly refurbished building and, according to the Assistant Principal, is increasing in popularity: numbers are “growing rapidly” and “students have responded to it really well...retention’s gone up”. The proportion of disadvantaged pupils across the school as a whole is higher than the national average: a fifth are entitled to free school meals. Most pupils are white British. The school’s Attainment 8 score is well below the national average, and its Progress 8 score is in the lowest fifth of the country. One in five pupils attains grade 5 or above in English and Maths GCSEs, compared to a national average of two in five.

In 2019, Bismut was rated *Requires improvement* by Ofsted, with 16-19 provision rated *Good*. The report notes a rigorous sixth form admissions process, with students guided onto appropriate programmes building on their prior achievements and their interests. Post-16 English, Maths and Business Studies teaching is described as “particularly strong”.

The teacher who responded to our requests for participants was about to take up a post elsewhere. We interviewed her, therefore, in July 2017, prior to the first full round of fieldwork. She had brought CM to senior management’s attention, having attended an event at the trust’s lead school, Lions, a Core Maths Early Adopter with a relatively large number of CM students. Senior management were persuaded that it was viable to run CM, pleased that it counted within performance measures. Also, as the Assistant Principal explains:

*“...it’s got a, got a big role, a big role to play for anybody that wants to continue, doing maths...it fills a gaping hole...that gap was obvious between GCSE resits and your A-level Maths, and, Core Maths is, has fit that perfectly, from what I see... the Academy’s very positive about it. Um, just being in there, that people have the opportunity to take it.”*

The access grade for Core Maths is GCSE grade 5, because of the likely gaps in knowledge of grade 4 students. The school initially taught Core Maths for three lessons a week over two years, to allow it to fit in with the reformed post-16 linear model. However, dropout between Year 12 and Year 13 prompted a change of strategy, as the Assistant Principal describes:

*“...we initially wanted to roll it out over two years, to give a similar two-year feel, that everybody’s here for two years, you don’t disappear after one year, and then realised that, for it to work properly, we would like to condense it to a year. Um, we found some of the initial students, I don’t know if the right word is drifted, but disappeared after the first year of study, and, under that sort of guidance, wouldn’t have got anything for it.”*

There were two Year 12 students in September 2015, neither of whom went into the second year. Six students started the course in September 2016, growing to 13 when seven students were moved out of A-level Maths into Core Maths. At the time of our visit in autumn 2017, the new Core Maths cohort had around 15 students and was running as a one-year course. This was also seen as advantageous because Year 13s could access Core Maths.

The Core Maths teacher used OCR/MEI at first, because of the Integral website. However, after speaking to a local Core Maths lead, she changed to AQA with Paper 2B (Critical path and risk analysis), because other schools were doing AQA and she liked the AQA syllabus’s financial aspects. Lions wanted Bismut to revert to OCR, to bring the academies in line. As of autumn 2017, Bismut were sticking with AQA, using the OCR scheme of work which the teacher said had been adopted by AQA anyway.

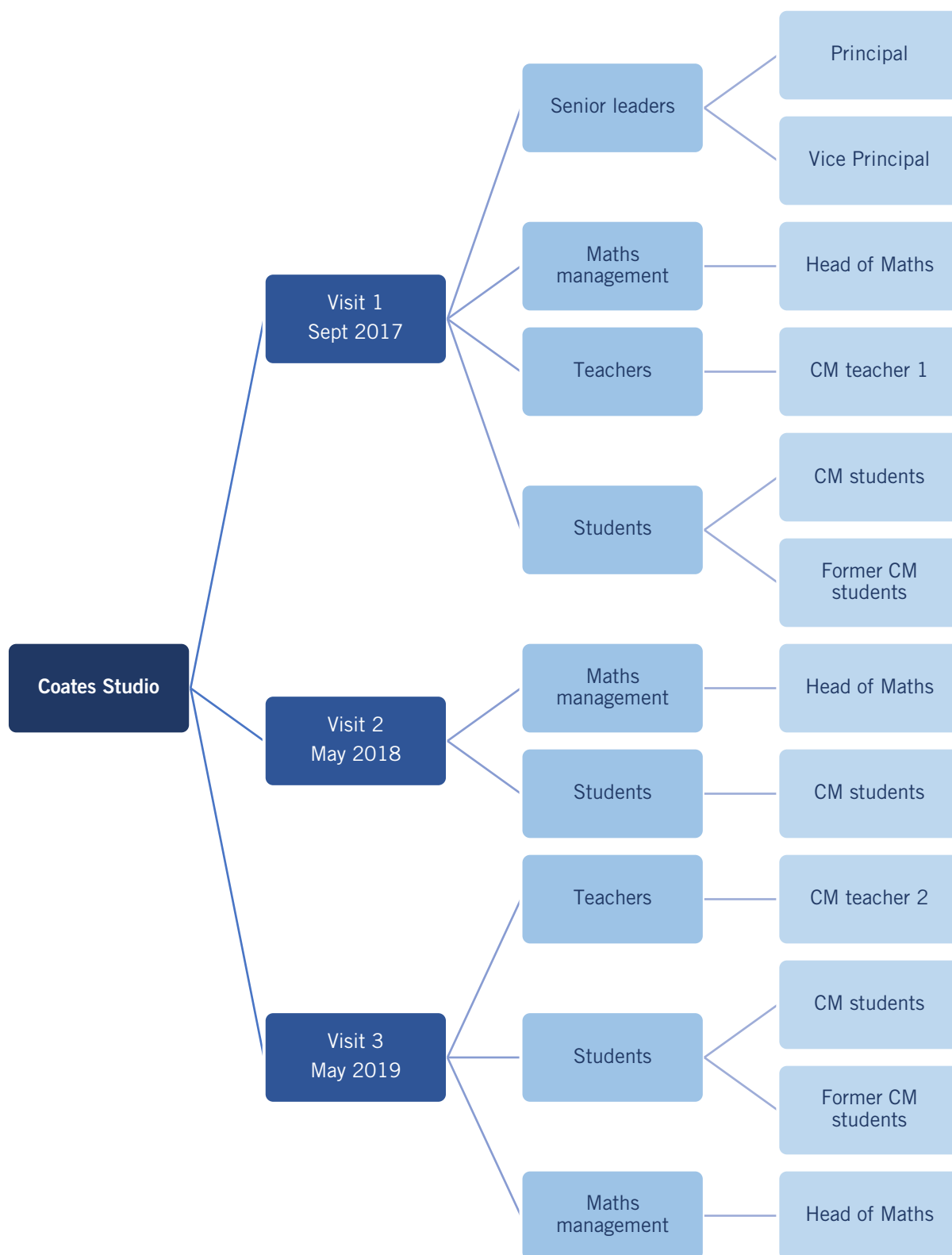
Bismut offers A-levels and some BTECs. The Assistant Principal explains that all students begin the sixth form with either three two-year options, or two two-year options plus Core Maths as the third. He describes it as “easy” to pair Core Maths in year 1 with EPQ in year 2, creating enough Guided Learning Hours for funding purposes. The school’s priority is that the student’s needs are met, he explains, which may mean taking on, not three full A-levels, but two plus the shorter courses. Core Maths is in the same option block as A-level Maths, to allow transfer. Some students wishing to take A-level Maths but not meeting the access criteria enrol on Core Maths instead, whereas others take a different two-year course.

The Assistant Principal says that maths staffing is reasonably stable, with peaks and troughs. He says that “it is a subject staffing-wise that does have the revolving doors”, explaining that maths staff can often command a better salary elsewhere; he reveals that Bismut uses the same method to attract teachers. Their current team are maths specialists, and they are not yet feeling the wider maths staff shortage. The original Core Maths teacher has a Sports Science degree, and would not be equipped to teach A-level Maths, though she enjoys the content of Core Maths. She tells us that other maths teachers have backgrounds in accountancy, the navy, engineering, law and business. In 2017-18, Core Maths teaching was split between teachers from two Trust schools, moving between sites.

Both Core Maths teachers said they had been to useful Maths Hub events. The second Core Maths teacher had also been supported by the trust’s lead school. The Assistant Principal explained the budgets limitations, the “extortionate” cost of external CPD, and the aversion to taking a risk on a course which might cost hundreds of pounds but prove to be less than useful. He also said that schools have begun charging each other for advice and support. He says one advantage of being part of a multi-academy trust is support and training, in the form of “opportunities to work with colleagues”, within the MAT.

The visit in September 2017 was only partly successful. Whilst the interview with the Assistant Principal was productive, the current CM teachers did not engage with the study as the original teacher had. The teacher delegated to manage the visit was called for cover when he was due to be interviewed. It proved impossible to engage the school in a follow-up visit, and, despite considerable effort, we let go of this case study.

## 5.6 Coates Studio School



Coates Studio School, sited in a former industrial part of a major city with a population of over two million, is one of four institutions which make up an academy trust in the North West of England. Deindustrialisation in the 1980s led to some of the highest unemployment in the UK, although economic growth occurred in the later twentieth century and regeneration continues. Studio schools have specialities, such as Sustainable Technologies, or Space, but, due to the small number of Studios (24, as of 2020<sup>55</sup>), to state Coates's speciality would risk its anonymity. It works closely with one of the other trust schools, with teachers teaching across both schools. The CM teacher who participated at the first visit was employed by the other school; the replacement teacher was employed by the Studio.

Like all Studios, Coates is much smaller than the average-sized secondary school, with around 300 pupils (roughly two-thirds boys, one-third girls) aged between 14 and 19 in 2019, including just under 100 in the sixth form. It recruits from a wide area, with students travelling relatively long distances to access its specialist provision. Almost half its pupils were eligible for pupil premium in 2015 (2019 data show that one in five is eligible for free school meals), but the proportion of minority ethnic pupils is smaller than the national average.

At its last inspection, in 2018, the school was judged to be *Good*. A significant number of pupils join the school following disruption to their education, and/or with below average progress in KS3. Incoming students may have had “terrible experiences” at other schools. The Head of Maths describes hearing students commenting: “I didn’t do any maths in Year 8. We had a succession of supply teachers, everyone was messing around and I couldn’t learn anything”. Students can choose from a wide range of vocational and academic courses, and they generally achieve well. It was identified that retention can be problematic in the sixth form, though this may be because students leave partway through their academic courses to take up apprenticeships or employment. The Ofsted report highlighted outstanding behaviour, and noted the maturity of students and the professional attitude of sixth-form students towards their work, though it also remarked that, in 2018, sixth-form students made below average progress in some academic subjects. The school achieves above average GCSE resit pass rates. A high proportion of students progress to HE, training or employment which closely matches their career aspirations.

Across the two trust schools, roughly 50 students (about ten from Coates) are taking A-level Maths. Three are taking Further Maths, fewer than the previous year and barely viable. The Principal came across CM because another Studio was teaching it and recommended it. He has an impression that employers will not know the difference between this new qualification and the more established A-level Maths:

*“The qualification framework’s changing so quickly that they’re really struggling to catch up. They see you’ve got a maths qualification, and it’s created like an A-level. So it looks like an A-level. Sounds like an A-level, walks like an A-level! (laughs)... and it doesn’t matter that it’s not, and students wouldn’t be selling themselves as having a Maths A-level but it’s just the fact that they’ve got more than GCSE, kind of sets them apart.”*

He says, “the key thing is that it carries UCAS points, and the key thing for the school is that it carries accountability, performance points, you know”. Amongst our case studies, it is unusual for management to highlight performance points as a benefit of Core Maths.

Coates's Head of Maths initially went with the Head of Maths from the partner school to a Core Maths meeting to find out about it and compare different awarding body specifications. She describes how her colleague wanted to teach Core Maths himself:

*“because he quite liked, the sound of the set-up of the lessons and this idea of, well, here’s a real world problem, what maths can we throw at it? And that’s quite, there’s something quite freeing about that actually, compared to some of the other specifications that you might teach.”*

Coates's Principal encourages staff to go on training courses, build networks across the trust and beyond, and become examiners in their subjects to become more familiar with assessment frameworks. The Head of Maths says it was useful, on courses, to meet other people already running Core Maths and learn from their experience. She describes a

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<sup>55</sup> <https://www.gov.uk/government/publications/open-academies-and-academy-projects-in-development>.

widespread concern amongst teachers about the new GCSE and A-level coming on stream at the same time as learning about Core Maths. The Core Maths teacher was pleased to find that there was no one right way of doing things, and appreciates the fact that because this is a new qualification there is little precedent or previous practice to follow:

*“It was like, OK, if this goes horribly wrong this year then we’ll learn from it, rather than, it being massively pressured.”*

Coates links CM with IT courses, offering the AQA specification with Paper 2B (Critical path and risk analysis) to align with the Computing, Programming and IT students at whom the course is targeted. According to the Head of Maths, Paper 2C (Graphical techniques) is the least popular of the optional papers, since there is enough algebra to lead teachers not to be confident that students would perform well:

*“A lot of the students who’ve maybe chosen Core Maths have chosen it because they want it to be more applied, and then if you’re getting them to do these abstract calculations, they’re not, particularly interested in it.”*

Students are offered the chance to study CM as part of what the school calls a “bundle”. If they take a Level 3 maths qualification, three technical qualifications and the EPQ, they attain a performance measure known as the TechBacc.<sup>56</sup> The CM course is taught over one year, so some students take Core Maths in Year 13 with two A-levels or equivalent, having withdrawn from one of their original two-year choices, alongside the EPQ to make up UCAS points. The school does not believe students would choose to do CM if offered over two years, as it is worth less than a full two-year course. Also, completing it in the first year post-16 means it is “out of the way” (says the Vice Principal) before students’ main exams.

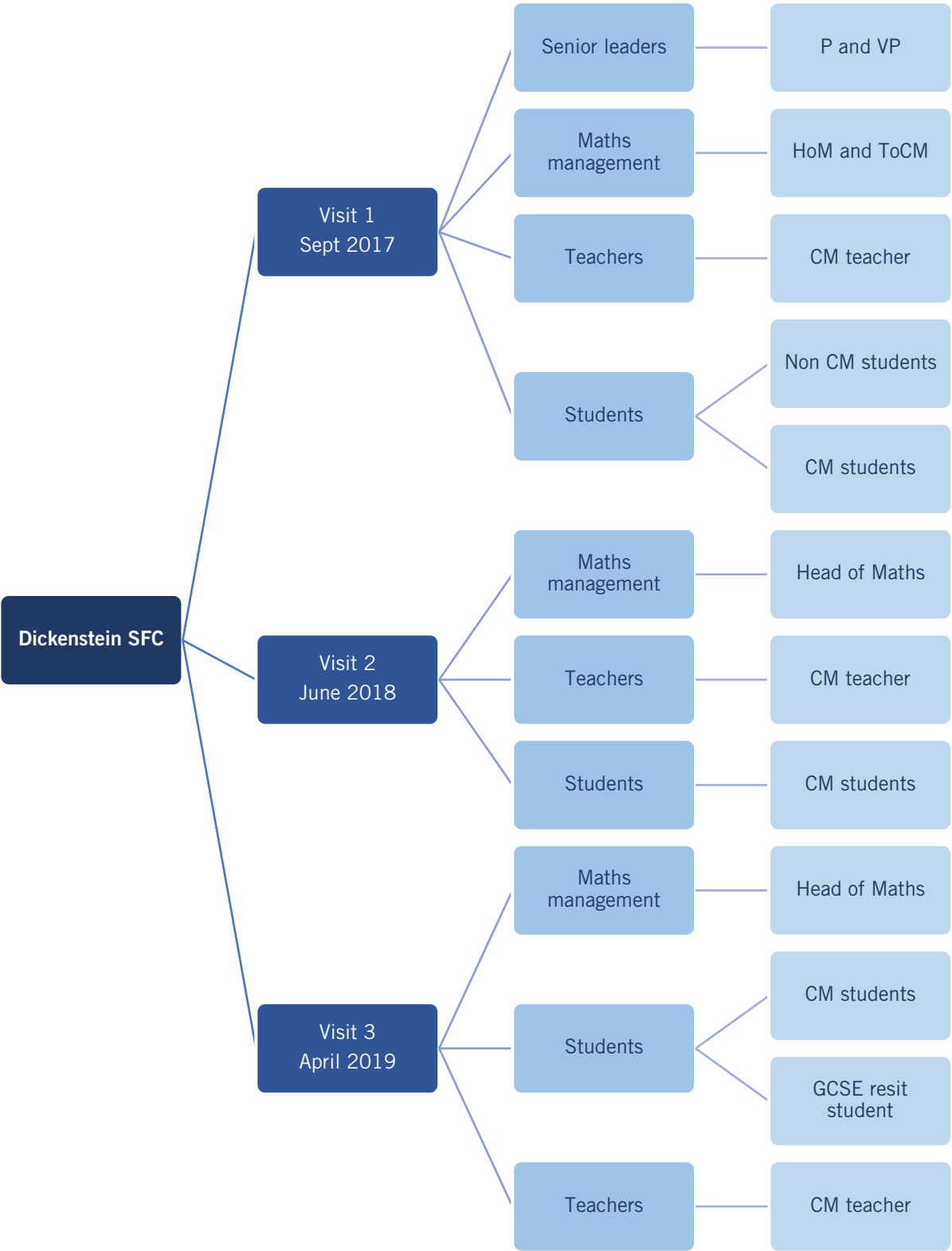
Four 70-minute sessions a week are allotted to Core Maths, whereas A-level courses are allocated these plus a further 50 minutes. The access grade for Core Maths is 4. In 2016-17, there was a small class of eight fairly able students, most of whom performed as expected. In 2017-18, there is a similarly sized class, but in 2018-19 only two students. The Head of Maths is uncertain as to whether the course will continue running with such low take-up.

During the study, the original Core Maths teacher left the school. A Studio maths teacher took over, though he was also about to move to a new school in autumn 2019. He says he enjoys teaching CM, with its emphasis on real-life applications of maths, as it is different from A-level Maths, which he also teaches. He says he promotes all forms of maths:

*“I’ve tried to sell all the post-16 maths. You know, your Maths, your Further Maths and your Core, because I think you need all three of them. Each one has their place for each specific student... I think, any post-16 maths studying is really good. I, I, you know, obviously, I’m biased, but in the real world being numerate is so valuable.”*

<sup>56</sup> Technical Baccalaureate. A performance measure comprising three technical qualifications, the Extended Project Qualification, and a Level 3 mathematics qualification.

5.7 Dickenstein Sixth Form College



Dickenstein is a sixth form college in the Yorkshire and Humberside region. It is situated at the outskirts of a city whose population is about half a million, and which suffered, like many northern towns and cities, from the decline in manufacturing industries and coal mining in the 1970s and 1980s. The area of the city served by the college has high levels of social disadvantage. Local unemployment is higher than the national average. Around two in three students are from minority ethnic backgrounds, a higher proportion than exists amongst local residents, and, for roughly one in five, English is an additional language.

The college was rated *Good* in all areas by Ofsted at its last inspection (2018). Ofsted remarked that diversity is celebrated and modelled, and that students from a wide range of cultures work diligently together and respect the views of others. The college is relatively small, with just over a thousand students, mostly aged 16 to 19, and faces competition, within manageable travelling distance, from schools, FE and other SF colleges, and more than one UTC. At the time of Wave 1 of the Area Reviews of sixth form provision in 2015,<sup>57</sup> the college decided proactively to join a local multi-academy trust, rather than risk being subjected to a merger with other post-16 providers, in order to maintain relative independence and develop local partnerships, and it became an academy in 2017.

Just over half of students have low English and maths attainment on entry: a high proportion of students (relative to other sixth form colleges) are retaking GCSEs in English, Maths, or both. In summer 2019, 400 students were retaking Maths GCSE. One in five students is studying at Level 1 or 2. Around 80% of students follow a Level 3 (pre-university level) main programme, 40% of them taking A-levels, the rest taking BTEC, CACHE<sup>58</sup> or University of the Arts, London (applied) courses. The proportion of students taking A-level programmes has decreased in the last few years. Most leavers progress to HE.

Students at Dickenstein do not necessarily have a two-year post-16 career followed by entry to university. Students progress on a yearly basis, sometimes staying one year, sometimes two, sometimes three or more. The Head of Maths reminded us, at the beginning of fieldwork, that, unlike schools, colleges do not refer to students as Year 12 and Year 13, because it would make no sense in their context.

Core Maths is taught over one year, and students with a GCSE grade 4 can opt into it during any year of their time at the college. Students taking a GCSE Maths resit in the first year post-16 can then move into CM. Core Maths was initially brought in due to the demise of A-level Use of Maths, which the main CM teacher had taught for many years, and which she and the Head of Maths say they miss. It was, as the Head of Maths says, “an alternative pathway for those students who aren’t strong enough to do the A-level Maths... Core Maths hasn’t filled that gap like we would like it to have filled that gap.”

Dickenstein teaches the OCR specification with Statistical Problem Solving: “We’re stats people”, says the CM teacher. The maths department say they have long received support from MEI advisors. The MEI Integral resource bank has also proved extremely useful: the CM teacher says it is “what I basically lived on last year”. Dickenstein maths staff also host maths network meetings and are part of local teacher networks. Staff can access training and CPD; in 2017, senior leaders noted an overspend in 2016-17 due to the amount of awarding body training which staff undertook around curriculum reforms. The maths team is relatively small, with seven teachers from a variety of backgrounds including a primary-trained Functional Skills specialist with an English degree and two teachers with Psychology degrees. The Head of Maths says, “Touch wood. We are not currently experiencing the crisis!” There are currently two CM teachers, one for each of two groups.

Core Maths was first taught here in 2016. Results were, according to the Principal, interviewed in 2017, “very good... so on quality grounds we’re comfortable.” At the first fieldwork visit in autumn 2017, the intake was over 60 students, and had been allocated three classes, with better promotion and recruitment by maths and non-maths staff at enrolment. Core Maths is promoted to students of subjects such as Psychology as a useful support course, and to students unable to access A-level Maths because of their GCSE grade. Core Maths is added to students’ three A-level (or equivalent) programme, which for many students is the triple BTEC (Extended Diploma) in Applied Science.

<sup>57</sup> For information about Area Reviews, see Foster, David, 2018. Further Education: Post-16 Area Reviews. Briefing Paper 7357, May 2018. House of Commons Library.

<sup>58</sup> Vocational qualifications for the care and education industry. See <https://www.cache.org.uk/our-qualifications-and-services>.

Indeed, at the time of the first fieldwork visit, students enrolling onto Applied Science were obliged to take CM alongside, with students being advised that CM would be helpful when applying to university. However, students applying to HEIs discovered that CM was not an entry requirement, nor did it count as a qualification, except at institutions where offers were made on UCAS points gathered from any qualifications. Some CM students found they were going to have to retake their GCSE Maths, in order to secure a higher grade, required by the university course of their choice. The college, already struggling to fulfil students' needs, now had another class to fund. Many students left the CM course, saying they would rather spend time focusing on their main programme, the Applied Science BTEC.

By the time of the second fieldwork visit, Dickenstein was left with three small classes, meaning they were stretching thin resources even further. Management said it would only fund two CM classes the following year, and recruitment had to be handled differently. The Head of Maths said she was considering whether to move to a two-year model, because of the more general move towards linearity over two years. She felt that the danger of students quitting any of their courses, or the college, had diminished because they were signing up to two years for everything now, and that the CM-related workload would therefore halve. This change did not, however, come about.

At the time of the third visit, 17 students were left in two CM groups, though the teachers told us numbers at the start of the year had been at least double that. Student comments indicated that dropout was attributable to two main factors: the amount of maths already in the Applied Science course, giving the students double helpings of maths, together with the discovery many students made that CM would not be accepted as part of an application to university. Students interviewed who were taking CM in their second year of the Applied Science BTEC were actually likely to say that the Applied Science course had fed into the CM course, rather than the other way round.

Repeatedly, at each fieldwork visit, the Head of Maths and CM teacher reiterate that the problem with CM is not the course itself: they observe, and are encouraged by the fact, that students who do complete the course demonstrably appreciate it, and are glad that they have persevered with it. However, in the current system, it is half a course. The Head of Maths says it is a “problem” in terms of funding, and in terms of fitting in with a student's programme, that CM has to be an “extra to somebody's three A-levels”.

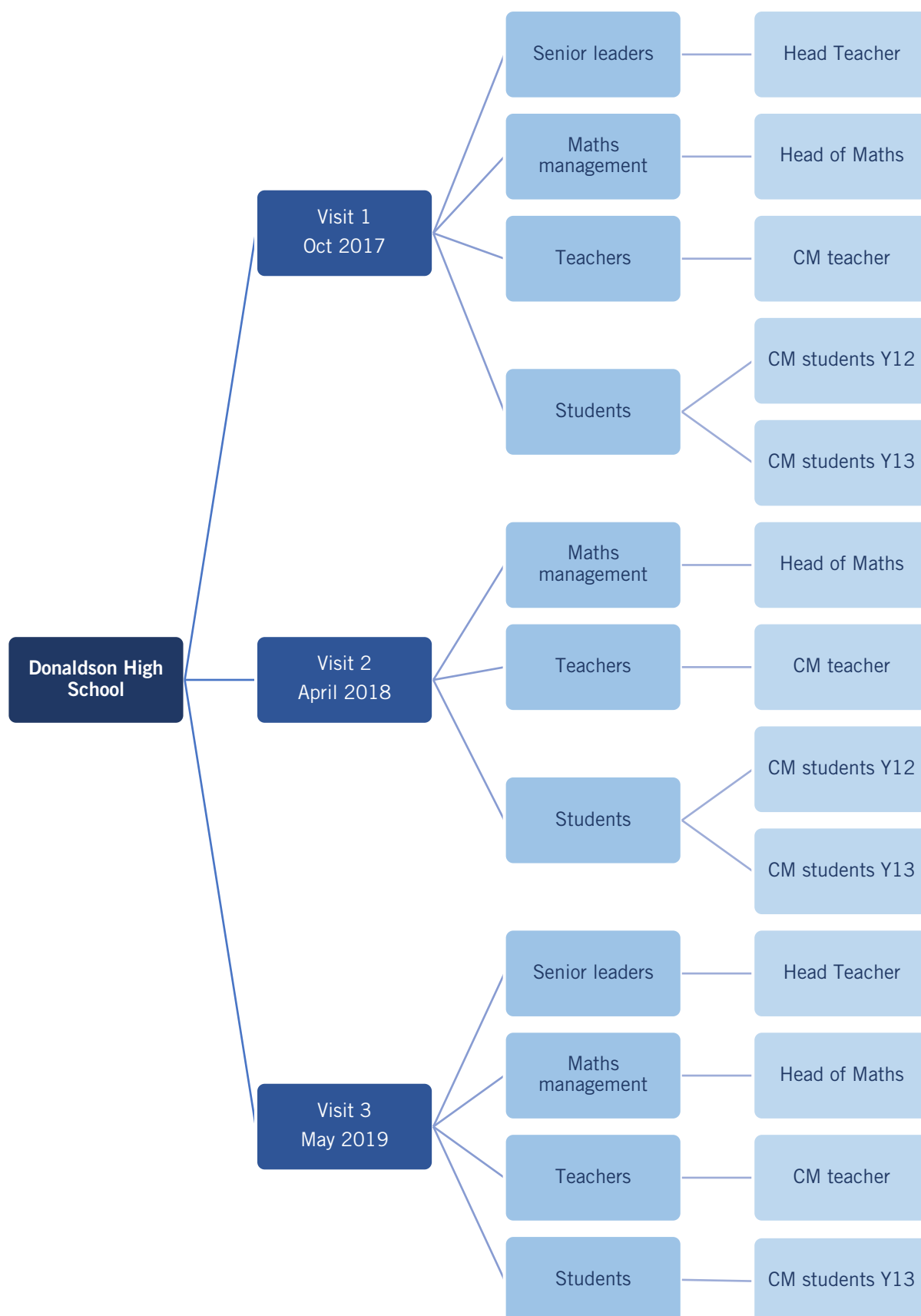
Framed initially by the college's Principal as an “opportunity” to gain an additional qualification, and to carry on with maths without having to take on A-level, the academic worth of CM is, she says, “intrinsic” rather than “nice-to-have”. The Principal says she has a gut feeling that “surely it is helping those students who are doing numerate subjects who might not otherwise be doing maths”, and speaks about stretching the college's funding to go that bit further, because of the benefits of Core Maths:

*“it's about adding value, for students, in some way, often about their progression.”*

Yet, at the third visit, the CM teacher says she is concerned that poor retention will inevitably lead to a decision by management to withdraw the course. The Advanced Maths Premium has brought no financial benefit for Dickenstein, as their numbers for CM and for A-level Maths have reduced over the baseline years. They have also learned from their “over-promotion” of CM and subsequent “big dropout” (Head of Maths) that this is not an effective strategy for the college:

*“I said earlier about promoting Core Maths so much at enrolment this year and there being a big drop out... I'm not sure the over-promotion has any long-term impact anyway... I think to do maths you have to enjoy it... if they don't want to do it, they don't want to do it... you're a business and you have to try and recruit your students. But, so if we pushed and pushed and pushed for them to do maths, they'd go somewhere else to not do it.”*

## 5.8 Donaldson High School



Donaldson High School is a relatively small maintained secondary comprehensive in the West Midlands of England, in a town with a population of around 130,000. There are just over 300 pupils in the school, with fewer than 50 (fluctuating each year along with local demographics) in a joint sixth form consortium with several other schools in the town. Being in the partnership allows the school to retain its sixth form. Most pupils are white British, and the proportion of SEND and disadvantaged pupils is greater than the national average.

At the last inspection (2018), the school was rated *Good*, up from *Requires improvement* in 2015. Progress to Key Stage 4 is higher than the national average, and progress for disadvantaged pupils has risen from being below average to being stronger than the national average. Pupils in all groups make strong progress regardless of their starting point. Attendance has been improved at the school and is now in line with the national average, and retention and attendance in the sixth form are positive. The Ofsted report mentions particularly that maths teaching is good and carefully matched to pupils' abilities; that maths attainment is above the national average; and that progress in maths is rapid, and now in the top 20% of schools nationally. There has been a change in the consortium-wide access policy, due, says the Head Teacher, to the increased demand, in terms of rigour and standard, of the new A-levels: students now need a higher GCSE profile to gain access to the sixth form at all, and students with a low attainment profile have to look elsewhere.

Donaldson began offering CM in 2015 as an Early Developer. The Head of Maths initially had some Core Maths training through the CMSP and the maths hub, and had a Core Maths advisor come into school to support him. He chose the AQA specification with Paper 2B (Critical path and risk analysis) because teachers from other schools whom he met at events were also doing AQA. He says he enjoyed hearing from teachers in other institutions and finding out how they were doing things. However, travelling the substantial distance to hub events and meetings was daunting, and in the year up to the final fieldwork visit, he has not been on any courses, or been involved in any network meetings or even email contact. He was unaware that the CMSP had morphed into the AMSP.

The Head Teacher believes that Core Maths is a good option for students:

*“because of the nature of the qualification and how it links to other subjects, I think that's a really valuable element, of what it offers... it provided students with an opportunity to continue maths, and maintain that subject within their profile for the future, which we felt was a really strong thing to do... it was something that was really gonna benefit a lot of our students.”*

It also allows their own centre to offer a post-16 maths qualification within the joint sixth form partnership; A-level Maths is taught at another institution within the consortium. The Head Teacher highlights that CM gives his teachers the opportunity to teach maths at Level 3. He praises the maths team and describes the Head of Maths as “an amazing teacher”.

The Head of Maths relates how teaching CM has prompted him to think differently about his Key Stage 3 and 4 teaching: “it's been really beneficial to me as a teacher”. He likes the CM course, promoting it to other teachers wherever he can, saying “I've pushed it 'cause I really like it. I think it's been really good.” However, he still does not know any other local schools doing CM, and wonders if it is difficult to persuade people of “the value in it”. He believes he is teaching better, more relevant maths when teaching CM than when teaching GCSE, and believes that a CM-like qualification should be available at Level 2. He particularly likes the freedom to digress and discuss, which is different from the structure and pressure of Key Stage 4. The CM teacher also appreciates being able to “break free of your shackles a bit”. The Head of Maths describes “fending for ourselves” as opposed to using any scheme or textbook, and both teachers say they regularly use newspaper articles as resources. Of our case studies, this Head of Maths's lessons are at the constructivist end of the spectrum, and involve the students sitting round a table, exploring, talking, and using the internet on their phones for fact-finding, with the teacher facilitating the unfolding of the lesson. He often uses the book “1423 QI Facts to Bowl You Over” to find starting points for his lessons:

*“Yeah, there was one about the number of meteorites that hit the Earth every hour or every day, and it was in the millions. We got a lesson out of that. The LEGO bricks to the Moon came out of this... I really like the challenge that that can bring, just in having to think about a few steps ahead of the maths that they’re doing to see whether or not it’s worth persevering with. Erm, the kids get to start with something that they find interesting and then find some maths from it. In the past, their experience of GCSE will be, or will have been, here are some things that you need to learn and then, let’s try and make them interesting. But it’s just so nice to have that freedom of, well, let’s just start with something that’s interesting and see what happens.”*

Donaldson runs CM over two years as “part of our additional enrichment and tutorial enrichment”, as the Head Teacher explains. It is timetabled for an hour each Wednesday afternoon, against extra-curricular activities, work experience, and volunteering; against the EPQ; and against sessions to get students from a GCSE Maths grade 4 to grade 5 if they need this for HE access. Last year, CM was initially afforded three hours a fortnight (a third hour every other Thursday morning) but, due to poor attendance, the Thursday morning hour was withdrawn and staff diverted to a higher priority.

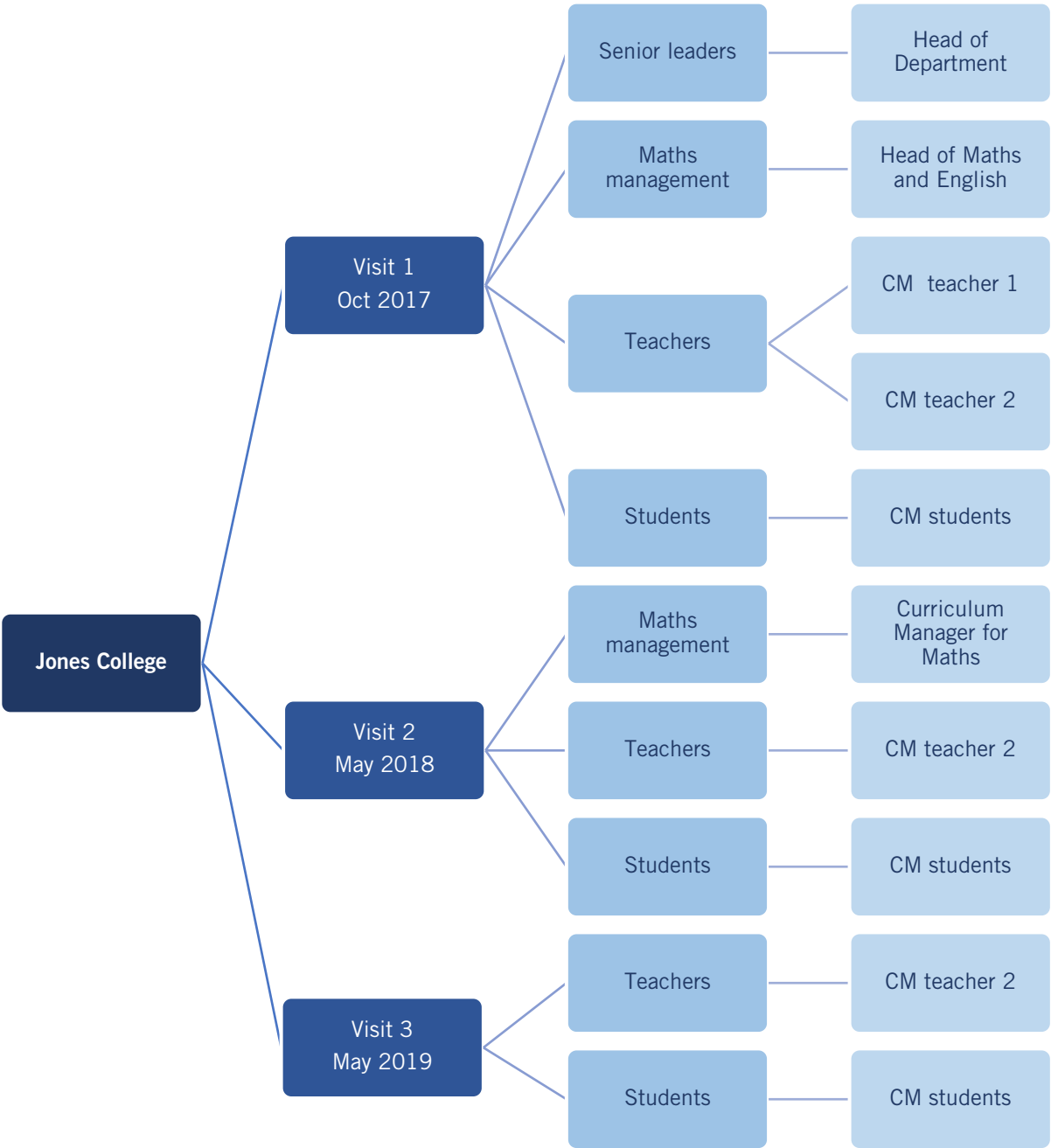
Students can access Core Maths with GCSE grade 5, though most students taking it have had 6 or higher. In the first year, there were three students, joined in the second year of the course by a student transferring from A-level Maths, who passed CM with a B at the end of one year. In 2017-18, eight Year 12 students began CM, and ten were in their second year. At the time of the second visit, there were concerns that the sixth form was going to be so small (fewer than ten pupils altogether) that the chances of running CM were very low. Indeed, no Year 12 group was formed in September 2018, and only two of eight students progressed into the second year of CM. As the CM teacher explained, the students’ bigger focus is on their A-levels, their “bread and butter”; CM is “additional”, so maintaining their motivation for maths is the biggest challenge. CM can be a casualty of wider priorities, in terms of both individual students and the institution. At the end of Year 12, following progress reviews, some students were advised to focus on their main programme, or swap from CM to EPQ, which attracts more UCAS points. Students continuing CM to completion have tended to need its UCAS points. One Year 13 student interviewed in 2019 had only two full A-levels and CM left, after a withdrawal, and was making up UCAS points with an EPQ.

In 2019, the two remaining students had both begun A-level Maths as well as CM, having achieved grades 7 and 8 in GCSE Maths, but had withdrawn from A-level, saying they had not been enjoying or coping with it, a situation they felt was not helped by the course being taught at one of the other consortium centres with a very different ethos. In summer 2019, the school was uncertain whether CM would run at all in 2019-20 because of low student numbers, and indeed in 2019-20 there is no CM class at the school. The school considered offering a one-year CM course, or even combining Years 12 and 13 in one class, as potential measures to keep running the course, but says both are impractical. They do not have the staffing capacity to run CM as a full-time course over one year; and teaching two year groups together would result in overly-challenging differentiation.

The Head of Maths knows about the Advanced Maths Premium, but has calculated that it would not benefit them, saying it would only be of benefit if a class of 30 suddenly appeared. Students opt into Core Maths, and the Head of Maths believes students should choose something else if they prefer. Staff can point students in a particular direction, and target students whom they know (having taught them in Key Stage 4) might be interested in Core Maths, but the choice is ultimately theirs:

*“I don’t wanna be forcing people through the door. It’s not what we want... We want somebody with, a degree of mathematical ability, a grade 5 or above at GCSE helps... We’re just looking for that sort of, that gap of kids who are able enough but not too able where they should really be doing A-level Maths.”*

5.9 Jones Further Education College



Jones Further Education College has five sites across a large town in the North West of England with a population of around 150,000. The town suffered in the 1980s due to the loss of coal mining and decline in a number of other industries, leaving a legacy of poor health, long-term inter-generational unemployment and low levels of enterprise, despite regeneration in recent years. Jones College works closely with the local enterprise partnership and other organisations to align its curriculum to current and future skills requirements in the region. In 2017, it incorporated a smaller FE college from within the region. The college now caters for over 7,000 students, offering further and higher education. Degrees are accredited by a number of universities. Over a thousand 16-18 students are working at Level 1 or 2 at the main campus, and just over 700 at Level 3. 700 students are resitting GCSE Maths.

The last Ofsted inspection (2017) rated the college as *Requires improvement*, reporting that retention, attendance and achievement were all too low. The proportion of 16- to 19-year-old students achieving GCSE English and mathematics at grades A\* to C (at the time of the report) was significantly below the already low national rate. Too many A-level students left their courses early, not developing their skills sufficiently or reaching their full potential. However, of the students on Level 3 vocational programmes completing their course, most made good progress and gained their qualifications. There is a mention in the Ofsted report about the engineering and IT students who study maths as part of their study programme:

*“...students in engineering and information and communication technology study mathematics to a level higher than that required by their qualification so that they are adequately prepared for further studies.”*

For the IT students, this is a reference to Core Maths, introduced specifically for Level 3 IT students who would potentially go on to study at Level 4. One accrediting university had noted that students taking IT degrees were faring poorly on the maths module. Investigation revealed that a typical IT student may have barely passed their GCSE, and not done any maths during the post-16 phase, entering Level 4 ill-equipped. Therefore, college policy is now to enrol Level 3 IT Extended Diploma students onto Core Maths, in order to support and develop their maths skills. Those with GCSE grade 5 or higher go straight onto a Core Maths programme; GCSE grade 4 students are taken through the GCSE course again before embarking on Core Maths, creating a two-year course intended at least in part to keep maths going throughout the two-year period. The Head of Department (part of the senior leadership team at Jones) says that, even if students do not pass the CM exam, they have at least been engaging with maths during that two-year period. He describes how the requirement to achieve desired outcomes, in this case relating to the maths outcomes of Level 4 IT students, has led the college to take on CM provision as an extra cost:

*“Business-sense-wise it's probably the craziest thing, I've ever done... but you've gotta do what's best for the learners and if I wanna give them a fighting chance at HE levels of getting the higher grades in all their academic studies, in all their modules, and Core Maths is part of it...it's bonkers from a funding point of view, but it's the right thing to do, for the learner's progression.”*

The number of students taking CM is small (ten or fewer completing the course in each cohort since 2015), especially compared with the hundreds resitting GCSE Maths across the college. Core Maths teacher 1 was asked to begin teaching the course in 2015; Core Maths teacher 2 picked it up partway through the year and by 2018-19 was the only teacher delivering the course. The teachers know why IT students have been targeted, but would like to see more students with higher GCSE grades on the course. They would also like to see other students being able to opt into CM. In 2019-20, CM has been extended beyond IT students to a cohort of engineers, meaning that 20 students have begun CM.

At the time of our first fieldwork visit in autumn 2017, the Head of Maths had recently joined Jones College from another FE college where she was part of the Maths Hub network, and where one of her colleagues was a CM lead in the region. She confesses that she might not have started CM if the decision had been hers, being aware of other colleges where there have been good intentions, but where retention has been a problem. At the time of the second fieldwork visit, there was a new Curriculum Manager for Maths, because of a restructuring following the merger. The original Head of Maths had been promoted to managing Maths across both sites.

Jones College offers the AQA syllabus with Paper 3 (Graphical techniques), the option which, it is thought, links best

with IT. The two Core Maths teachers say they would like to offer different options to different groups of students if numbers ever increased: Statistics for Business students and Graphical techniques for engineers. The one remaining Core Maths teacher in 2018-19 says it would suit him better personally to teach statistics. The teachers say AQA is the most accessible specification; in addition, one of the teachers mentions previously teaching OCR A-level Maths, saying “it nearly killed me” and put him off considering OCR for CM. The CM teachers do value the course and enjoy the opportunity to teach at Level 3. They have been on CM courses which they say have seemed more about publicising CM than giving practical pedagogical help. They use the AQA roadmap and the many links provided, and say they rarely make resources out of the news. They also say it is not straightforward to get hold of practice papers, though this is improving over time.

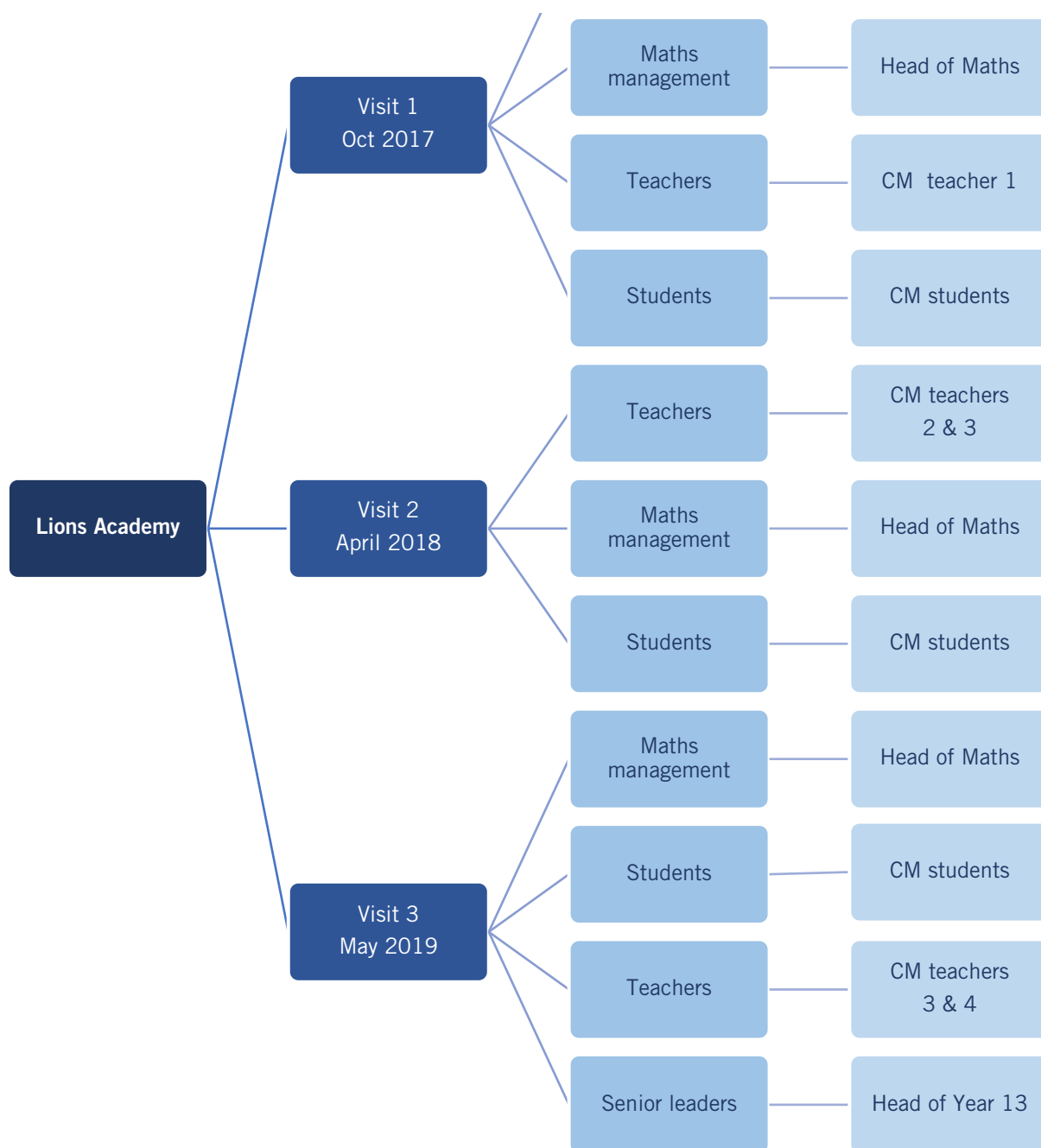
Both teachers bemoan the fact that they are revising a lot of GCSE material with students who are very weak. They are frustrated by the students’ lack of skill:

*“they don’t know things like percentages...It really made me question, you know, what’s the value of a C grade at GCSE? ...they lack the maths skills to do the course [CM]...[and] probably shouldn’t have been entered for it.”*

Some IT students did achieve higher grades at GCSE Maths, and have the opportunity to work towards the TechBacc, consisting of their Extended Diploma plus Core Maths and the EPQ.

Over the three fieldwork visits, we found individual students or groups had had different experiences of starting out in GCSE classes and being moved into CM, or starting straight into CM, and the college trying to find the best way to manage this. Teachers told us there is not enough work to make CM into two years, but one year is not enough for those coming from a low baseline (GCSE grade 4). For some cohorts, students have been entered twice for the CM exam, at the end of year 1 and year 2; some students voted with their feet and left the course having entered once, even if they failed. CM teachers say that the students are generally “not very motivated”. Student interview data indicates that students are resentful at being “forced” (as they say) to continue studying maths beyond GCSE. In particular, students who achieved a GCSE grade 4, under the impression they would no longer have to study maths, feel aggrieved. This is felt particularly acutely when CM is timetabled on a day when they would not otherwise have had to come into college, highlighting the fact that students are quite sensitive about how much control they have over their time. When CM is timetabled adjacent to lessons for their main programme, they are more willing to accept being timetabled for an extra course. When it requires them coming into college especially for CM, they are more likely to be non-attenders and/or drop out altogether. CM is allocated three hours a week. The 2018-19 cohort have been timetabled for 90 minutes either side of an hour’s lunch break on a Wednesday, resulting in the day being taken up by CM, which “blocks up” (as one student puts it) Wednesday.

## 5.10 Lions Academy



Lions is the lead school in a multi-academy trust, to which Bismut Academy (q.v.) also belongs. It is situated in a small East Midlands market town and is one of the highest-performing state schools in the county. It has roughly 1500 pupils, of whom just under 300 are in the sixth form. Fewer than one in ten is eligible for free school meals, well below the national average; most pupils are white British. Lions converted to academy status in 2011 and was designated a teaching school in 2012. At its last inspection (2012), it was rated *Outstanding*. Ofsted said that pupils demonstrated higher than average attainment on entry to Year 7 and at Key Stage 4. It said most post-16 students made good progress, meeting or exceeding their individual targets, and noted the quality of learning in sixth form lessons.

The Head of Maths describes his department as “really strong”, creating a positive learning atmosphere where students enjoy maths. As a teaching school and a lead school in a MAT, it was well placed to be a CM Early Adopter. One Lions teacher became a CM lead for the CMSP. Different views were aired around the amount of CPD in the Early Adopter year. The Assistant Principal says there was a lot, but teachers describe how they “built it up from scratch”. One, an NQT in that first year, tells us she received no CPD before teaching CM, and that then they had to deliver CPD on it to teachers from the other trust schools:

*“me and Mr. [Core Maths lead] have delivered it. ‘Cause obviously we did it the year before everyone else, so we’ve given them all our, resources that we worked so hard on! I found the first year very stressful trying to, create questions all the time, in order to test them... I found it a lot of hard work, when it probably didn’t need to be.”*

She sums up the interview (in 2017) by saying:

*“I think it could be a fantastic course. Um, I just don’t think there’s a lot of stuff to support it”.*

The school teaches the OCR specification over one year. One teacher says the previous Head of Maths had a connection with OCR, and that the OCR specification looked the most interesting. Staff do not have a printing budget, so they use AQA textbooks, and the Integral website. It is blocked against A-level Maths, to facilitate movement between the groups.

CM is taught in two double lessons per week, as are A-levels. Students feel prepared for the exam, saying they have done plenty of practice papers and questions. The Assistant Principal states that results have always been pleasing, and highlights that “Core Maths always improves our overall [value-added] scores, so it must be positive”. CM is available to any student, and is in several option blocks, for Years 12 and 13. The access grade is 4, whether Higher or Foundation. Although grade 4 students find CM harder, they are, according to teachers, often interested and motivated: there is none of the maths which they did not like at GCSE, such as algebra. The CM teachers report that students who attained lower GCSE Maths grades can now find success in many aspects of CM, often gaining confidence because they are not being faced with lots of new content. They also report hearing students making the links themselves between CM and their other subjects. Students say they see links between CM and other subjects, including Biology, Business, Physics and Chemistry.

There have been three CM groups per cohort over the last few years. Six of the maths team have had experience teaching CM, as the Head of Maths makes a point of introducing different teachers to CM. Each CM group has two teachers, allowing them to teach to their speciality, which generally breaks down to those who are comfortable or not with statistics. In theory, sharing a class is more successful in a school sixth form, where staff know most of the students from teaching them in Key Stages 3 and 4. Sharing a class in a sixth form college, for example, is more challenging for the teachers, in terms of getting to know the students, if they only see them for one session a week. However, one of the Lions teachers does comment that students do not always cope well with teachers sharing the class, as their experience can become disorganised and fragmented.

In 2017-18 the groups are of 13, 10 and 9 students. One teacher says these numbers are lower than the previous year, because more students this year enrolled on A-level Maths. In 2018-19, the three groups total just over 50 students. One CM teacher says this is “not loads”, as there were more CM students when they used to take a fourth subject in Year 12. Lions has moved to a three-course study programme. Even Further Maths is not run as a fourth

option, but a third. Since AS has not been routinely offered, fewer students overall are taking maths post-16: over half the cohort used to take maths of some kind (A-level, CM, GCSE resit) but now students' options are restricted at the start of Year 12.

The Assistant Principal is not concerned that offering CM as an extra course to three full courses will cost the school anything extra. Rather, he sees CM as part of a three-course study programme for those students who are low on Guided Learning Hours. Student data from our three visits supports a norm at Lions of including CM as one of three subjects; those taking CM as an extra course to three other full courses are in the minority:

*"...it's more likely to help us, if there are kids who are low on their Guided Learning Hours, then, obviously that'd be telling us that they're not taking enough qualifications, so then we might encourage them to take that as one of their qualifications, if it's appropriate."*

No AS courses or exams are being offered, except where students look unlikely to complete a two-year course successfully: they may be offered an AS exam at the end of year 1, picking up a different option - which could be CM - in year 2. Using the one-year version therefore offers flexibility: Year 13 students who have withdrawn from other two-year courses can pick up CM in Year 13. About a third of students in the 2017-18 cohort are Year 13; another is Year 14 as he is staying on for an extra year. Students leaving after one year of post-16 can take away a CM qualification studied in Year 12, possibly along with some BTEC modules.

The Head of Year 13 underlines that it is not always for the maths that students take up CM:

*"some will do it purely because there's literally nothing else they can do, which, it sounds horrible but a lot of the time it could just be a case of, we need to make up your timetable. So, it ranges from kids who really want to do it, really want to pick it as an option because they can see the benefits of it, right down to it being a last-ditch resort to make up the timetable."*

At the second visit, the Head of Maths spoke about a concern within the school that students are restricted by the inclusion of CM within their main study programme, as they do not achieve three full qualifications, and that this was going to change; but at the third visit CM was still predominantly included as one of three options. The school offers the EPQ to make up the second year, or a Level 3 Certificate in Criminology (WJEC) which has the same range of points as the EPQ. We have not encountered this qualification in any other institution, and it shows that the school has investigated the best ways of its students achieving the maximum number of UCAS points from their study programme.

Students themselves are aware of how taking CM as one of three options determines their post-18 options and defines them as a certain 'type' of student:

*"because it's this one year, oh, I can't fill my whole time with it at Sixth Form, course, it's people like us three that have ended up defaulting on to it, that end up on it, and we enjoy it, but because it doesn't seem the same as a two-year course..."*

Students at Lions were the most aware of, and the most outspoken about, the different status of CM when compared with A-level Maths:

*"it's [CM] marketed at people who aren't good enough to do A-level Maths, and I think that's not really doing it, doing it a bit of an injustice, to be honest, because I think it is something that's practical and useful and something that should be recommended to people who want to know how they can apply maths to real life".*

Students with GCSE grades from 4 to 9 do opt in. Those taking CM alongside three A-levels generally have higher GCSE grades. By our third visit, there had been a sea change in approaching recruitment to CM. The Assistant Principal said in 2017 that CM had fitted better with a weaker cohort the previous year, whereas the current year's

cohort had a much higher aspiration of going to university; he speaks about the students who have “normally chosen A-level subjects” as “not normally necessarily your Core Maths cohort”. By 2019, the Head of Maths describes how students with high GCSE grades are no longer necessarily encouraged automatically towards A-level Maths, and that the school is encouraging high-attaining students onto CM. He, and the Head of Year 13, say the message is no longer that students do CM if unable to access A-level Maths. “Don’t rule kids out”, says the Head of Maths. CM is about different maths.

The Head of Year 13, who is the school’s UCAS co-ordinator, highlights the usefulness of UCAS points gained from CM, which have enabled “quite a few students in the last few years” to gain a place at university:

*“...we find it really useful. We’ve actually called it a points booster.”*

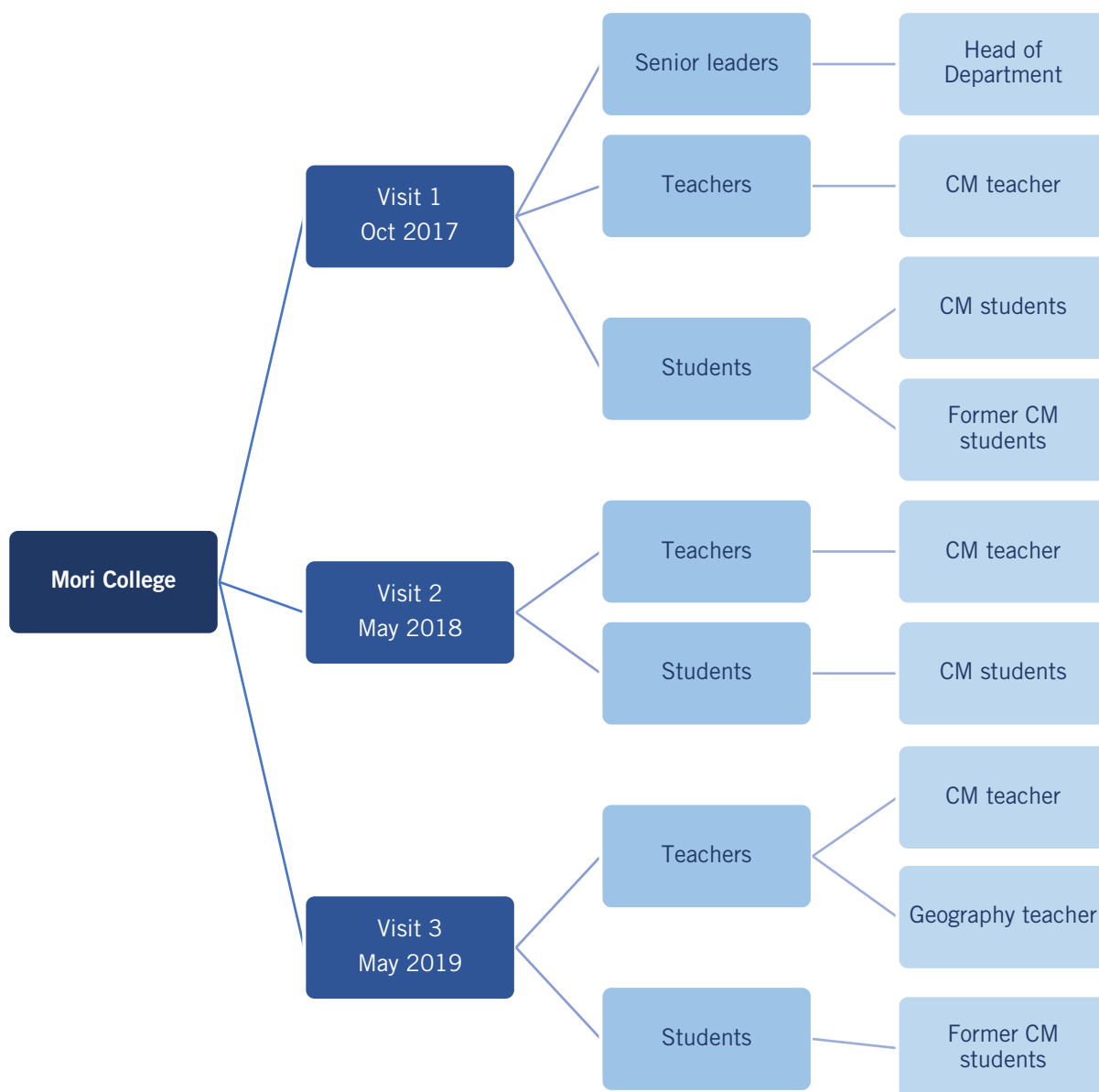
In addition, at the third visit to Lions in 2019, the Head of Year 13 indicated that students were coming back from HE interviews reporting that admissions tutors were pleased to see students taking CM in addition to their study programme. The qualification is not counting formally in terms of a grade, but on an individual basis it seems that the fact that a student has done that extra maths has helped them secure an offer.

CM seems better integrated at Lions Academy than any other case study. Staff beyond the maths department are aware of it. It is discussed in Year 11 in options interviews. There is a CM noticeboard in the maths corridor near the sixth form common room. Taster lessons take place in Year 11. In recruiting students to CM, teachers actively tell students that Core Maths links with other subjects they may be doing now, or at university, and that it is useful for real-life applications. The Assistant Principal sees CM as here to stay:

*“...the government keep talking about wanting every kid to take maths... So at the moment that’s the only other qualification there is... So, I can’t see it going away at the moment... You can’t take it away, ‘cause it’s part of our system now!”*



### 5.11 Mori Sixth Form College (part of a wider further education college)



Mori Sixth Form College is part of a wider FE college partnership, which, during a further merger in 2017, was incorporated into a large organisation serving 15,000 students across six locations in the North East. The college recruits from one of the North East's least deprived boroughs, albeit with pockets of high deprivation. Close working relationships with the local enterprise partnership and other bodies help the college to meet the evolving requirements of employers and the local community.

The last time the sixth form college itself was inspected, in 2016, the college was rated *Good*. There were around 3,000 students, the majority of them aged 16-18. Almost 800 were studying at Level 3, and around 500 studying at Levels 1 and 2, following study programmes across a range of academic and vocational courses. At the time of the inspection, there were around 250 students on AS- and A-level courses and around 1,000 students on vocational courses. Achievement and progress rates for 16-19 students were generally high; the proportion of 16-18 students improving their English and mathematics skills, often from very low starting points, was good; study programmes were well managed; a high proportion of students achieved their qualifications; the large majority of students progressed into positive destinations (further study, employment or apprenticeships) when they completed their programme of study. Students come to the Mori campus from around half a dozen partner schools without sixth forms. In 2017-18, around 20 students were studying A-level Maths in both Year 12 and Year 13. Further Maths numbers have decreased, with fewer students starting the course in 2018 than 2017; numbers for both years are below a dozen. Mori still offers AS exams, which is a minority position amongst our case studies.

CM was introduced at Mori in 2016, to replace Use of Maths. The CM teacher, one of two maths teachers at Mori, used to teach Use of Maths and says, "it just made sense to transfer me across" to CM. He says he did not have any Maths Hub training, though in the first year he was supported by a CMSP regional advisor who came to the college. He attended a three-day course in Manchester (a long way away), which he felt was more geared around subject knowledge and aimed at people who had not taught Level 3 maths before. He chose the one-year option, reckoning that the risk of dropout midway through a two-year course was too great. He opted for Edexcel, recognising some overlap with the Edexcel A-level with which he was familiar. He adds that he did not want to teach Fermi estimation, which is in the other specifications and is "not for me". CM is currently given the same number of hours per week as an A-level, which the teacher says is sufficient. He believes there is not enough content for two years: the course would have to be "dragged out". He prefers to "compact it down" to one year, so it is "out of the way". He acknowledges that students still feel pressure on their time, when taking it as an extra course, or have a gap in their year 2 programme when it is a third option. The Head of Department echoes this:

*"It would be useful if the students could study beyond just AS level or the Level 3 Certificate, whatever it's called... that would be a, a real, um, plus for us, if we could put them on a two-year programme, which had, the UCAS tariff attached to it, for when they make applications to university.... it means they have another choice to make next September, about an AS to pick up, um, if they're gonna progress on to university."*

Students access CM with GCSE grade 5. The main recruitment strategy is to offer CM to students interested in taking A-level Maths but not attaining the necessary GCSE grade (usually 6). Students also come to CM after the first year of A-level Maths, if they do not make the grade to progress into the second year. The Head of Department states that the course has been run "reasonably successfully", that the college is above benchmark for CM, and that students are better off achieving a grade for CM rather than not achieving a grade, or achieving a low grade, for AS Maths. One student, who achieved a grade 7 in GCSE, is enrolled onto CM because of a timetable clash preventing her from taking A-level Maths. The Head of Department and CM teacher both say that they are simply looking for students who wish to study maths. Once they arrive, they are allocated to either CM or A-level, depending on their GCSE grade, and a diagnostic test. The Head of Department admits that this approach risks portraying CM as a second best option, but at least students still have the opportunity to study some maths. As the CM teacher explains:

*"...if students come here to do maths and find out that the AS Maths isn't for them, and they find it too difficult, it's a safety net. It means they can still continue to be a student here, and do the other subjects that they want, plus they're doing some maths."*

It is recognised, as acknowledged here by the CM teacher, that some students will enrol on another subject entirely, and do not do any maths at all:

*“...‘cause it’s a one-year course and it, it doesn’t lead on to anything in the second year. So I think if they’re gonna pick up a new subject they might as well take it up and get a full A-level in it. I think. That’s the reason behind it.”*

CM is in the same option block as A-level Physics, rather than A-level Maths, meaning that it is difficult for students to transfer from A-level Maths to CM other than at the transition between first and second year; also, students taking Physics are precluded from taking CM.

From informal classroom observation, Mori’s CM teacher, amongst our case study teachers, was at the transmissionist end of the pedagogical spectrum. The Head of Department similarly advocated an approach of “Heads down, no noise...working their way through past questions and, whatever it is they’re set in that, in that particular session.” Students said they felt well prepared for the exam, and in fact Mori students are some of the higher achieving CM students in our case studies, potentially because a larger proportion of them had transferred after a year of A-level Maths, or only just missed out on being accepted onto A-level Maths, as the CM teacher explains:

*“It was successful, we got, we got a few A grades and B grades and C grades which, you know, is great, to get in the first year...A lot of those As came from students who’d done AS and A2 Maths before, but one of them hadn’t, and it was great to see.”*

The teacher tells us there is no specific textbook for this course, apart from an Edexcel student project book which, he says, is not ideal because it does not have answers and because students would have to buy their own. He says, “I have got a little bit of something, for everything on the spec, but it just seems to be a little bit there, a little bit there. Um, there is no one book which I can pick up and have everything in... which, I, I kind of, would like to have. AQA have one. But, Edexcel don’t.” He does not tend to make his own resources. He uses the GCSE Statistics textbook (“half the course is in that book”) and bought multiple copies on eBay from a school which was selling them. He also uses the old AS Maths S1 textbook, because of the overlap, and says sequences and series can be taught from the old Core 1 AS Maths textbook. Part of his reason for wishing there was an Edexcel textbook is to obtain clarity on some aspects of the specification. The feeling of not quite being sure he is teaching the right thing is not uncommon amongst our case study teachers:

*“...sometimes what’s written in the spec isn’t very clear. For example, I think the spec says something to do with histograms, but, is that, um, where the area’s equal to the frequency or where it’s proportional? And I, I had to email Edexcel to get that clarified...‘Cause it just wasn’t clear...Um, if we’d had a book hopefully, everything would become more clear.”*

The teacher is positive about the qualification itself, saying “I hope it doesn’t go away, ‘cause I do like it, as a qualification.”

Other subject staff are asked to promote CM to support their own subjects. Some staff are indeed supportive of CM and the CM teacher. We were able to interview a Geography teacher who described the overlaps between Geography and CM content. She also related how students had benefited from being able to practise the statistical and graph skills, giving them confidence, which is, she says, “the main thing”.

With regard to the question of whether teachers of other subjects could deliver CM, the CM teacher tells us he would be “worried” if non-mathematicians were to teach CM:

*“For any level of maths, I’d be worried...you need some understanding of beyond that...easier to deal with questions for students, get students thinking about different methods to approach a question... as a specialist I’ve got that. Other people wouldn’t.”*

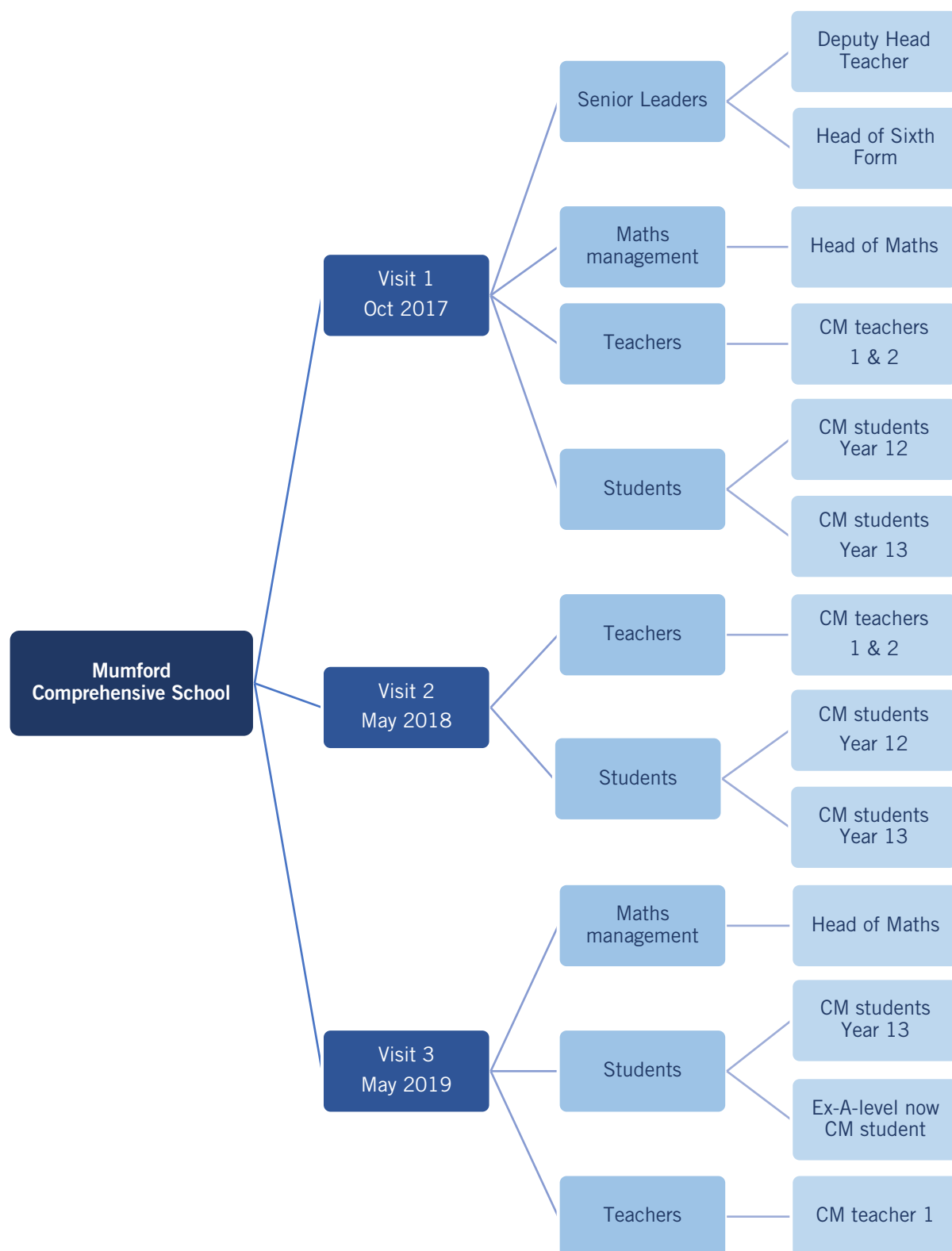
Whilst the CM teacher has read about the national maths teacher shortage, he thinks it is more of a problem at Key Stage 3 and 4. The Head of Department explains that their relatively small sixth form manages to continue delivering the curriculum by employing part-time staff, who are paid less than other teachers. He describes levels of funding in the post-16 sector as being insufficient to attract good staff:

*“It simply isn’t enough, to guarantee these students a quality experience, in my view. Nor enough for us to attract the level of skills in staff that we need in order for the curriculum to be successfully delivered.”*

At our summer 2018 fieldwork visit, Mori’s Head of Department told us that the course was safe, “without doubt”, because there would always be students who wanted to take A-level Maths but who could not access it. The CM teacher equally told us they “will always” have half a dozen students moving to Core Maths after the AS Maths induction test. Over the summer, in the greatest of ironies, one of the two maths teachers at the sixth form part of the wider college was made redundant, as a result of a further merger, and CM was withdrawn, because A-level Maths took priority for the remaining teacher. We did still make a third visit to the college, in summer 2019, to follow up the students who had taken CM the previous year, to take the opportunity to interview the Geography teacher, and to see what the prospects were for reintroduction of CM. In fact, provision had been made in 2018-19, as usual, for two A-level Maths groups, but the number of students had dropped to 9 across the two groups, from more than double that at the start of the year. More than usual had ‘failed’ the initial assessment, or, having signed up, decided not to persist with the course. This year, there was no CM for the students to move into. The Head of Department was considering having one group of A-level and one group of CM, if the same numbers were involved the following year.



## 5.12 Mumford Comprehensive School



Mumford Comprehensive School is a large mixed secondary school, of around 1800 mostly white British pupils in the Yorkshire and Humberside region, which became an academy in 2019. The popular sixth form of around 350 students welcomes around a third of its Year 12 intake each year from several other local schools. Pupil Premium is above the national average, at around a third of the school population. At the last Ofsted inspection (2017), the school was rated *Inadequate*, although the sixth form itself was rated *Good*. The report commented that sixth form leadership had improved, students following vocational pathways made good progress, and students on academic programmes made broadly average progress. Advice and guidance for students wishing to go to university was said to be good, with some students gaining places at prestigious universities, but more needed to be done for students wishing to follow apprenticeship and employment routes.

Core Maths was introduced at Mumford in 2015, after the Deputy Head Teacher read in both the Labour and Conservative Party election manifestos that increasing participation in post-16 maths was to be a government priority, possibly to the extent of post-16 maths becoming compulsory. The senior leadership thought the school should, as the Head of Maths explained, get “ahead of the game”. The Head of Sixth Form and Deputy Head stress Mumford’s commitment to offering post-16 students breadth of study, and believe that Core Maths offers students the chance to stand out by going beyond their “baseline of three qualifications” (Head of Sixth Form) to include maths in their portfolio. They also believe continued study of maths supports other subjects, particularly mentioning Economics and Applied Science. These factors motivate Mumford staff to offer Core Maths to all students as an enrichment.

The Head of Maths initially attended a Core Maths training course to find out about the different specifications, before teaching began in 2015. She had not noticed that the local Maths Hub was running anything in particular for Core Maths, nor has she since; her training was at a Maths Hub a little further away. The Head of Maths asked for a volunteer to teach CM, and an A-level Maths teacher, who teaches the statistics element of the A-level, offered to take it on. In 2016, another maths teacher, who does not teach A-level, began teaching a second cohort, delighted to be involved in some Level 3 teaching. Both teachers are enthusiastic about CM. One says, “it’s kind of the highlight of my week”. The other describes how “I’ve been teaching it now for two years, and I see the merits of it. I enjoy teaching it.”

The Core Maths teachers would like to communicate more with teachers of other subjects within the school, finding out how Core Maths could fit in with what they are teaching. CM teacher 2 tells us at the third fieldwork visit that more teachers are becoming aware of Core Maths and starting to see links with their subjects.

Mumford offers the OCR specification over two years. This works for them, because, as CM teacher 2 says, the students mature over two years, and the course is less pressure for the students because it is spread out. The attitude at Mumford is that “we get to do the depth over two years rather than trying to push it all in and cram it in”. CM teacher 2 says:

*“it’s almost like this is not a course that’s putting them under pressure, if you like, it’s a course that’s giving them a cause for thought.”*

Both CM teachers believe that all Mumford’s post-16 students should be studying the financial maths, and that careers advisers and staff more broadly should be made aware of the benefits of the course, so that they can encourage more students to enrol.

Students enrolling on Core Maths need at least a grade 5, and the teachers have found that students who have done Foundation GCSE struggle and tend to give up the course. One of the teachers notes that it is difficult to teach the course when you have a student with a GCSE A\* sitting next to a student who has taken Foundation.

Core Maths is run as an enrichment at Mumford, and is taught in a double lesson of just under two hours on a Wednesday afternoon. The EPQ, Further Maths and an AS in Criminology are other academic enrichments offered in that same enrichment period, along with extra-curricular activities including film club, debating, music, learning a language, and sports. Students opting into Core Maths predominantly take the course in addition to three other subjects; some students do drop one of their three two-year options at the end of the first year, and might then pick up an EPQ or an AS in their second year to make up their guided learning hours and their UCAS points. Senior managers relate how they thought hard about how to position Core Maths, and where to place it within the school’s timetable

structure: putting it in a curriculum option block would pit it against two-year courses which students may want to choose, and render it the equivalent of a full qualification, which is not appropriate; the enrichment block is, as the Head of Sixth Form says, “the place where we felt it would give most opportunity for students to opt into it, that really wanted to do it.” However, teachers describe problems with attendance, and ultimately with retention, when students see friends taking part in non-academic activities in the enrichment period. As CM teacher 1 says:

*“It’s trying to get pupils mature enough to actually see that it is useful... it should be quite easy in sixth form but it’s not... attendance isn’t always great, ‘cause like all their mates have either got free periods so, say it’s a sunny day they might, go elsewhere instead of attending a lesson... Like you’re competing, if all their friends are free.”*

Numbers are not high, compared with other enrichment activities: the EPQ attracts about 40 students each year, and Core Maths has had between 10 and 20 students starting it in each cohort, dropping to single figures in the second year. Of the first cohort, which started in 2015, only four students took the exam in 2017, attaining two As and two Bs. In 2018, not enough students opted for Core Maths to be able to run a group. CM teacher 2 became the only Core Maths teacher, taking the 2017 cohort through into their second year, with 12 students, though there was no dropout between year 1 and year 2 of the course.

Unlike others of our case studies, it is unusual for a student to move from A-level Maths to CM after one year, because of the problem of then not having three full qualifications. The Head of Maths tells us that a student moving out of A-level Maths, generally an able student, would take on a BTEC and do two years’ worth of modules in their second year. At our third visit, one student had moved from A-level to CM, and was also taking AS Psychology in a Year 12 group. She was applying to university using the UCAS tariff.

Senior managers describe the cuts in post-16 funding which have affected this and other schools and colleges. They say Core Maths may not run in the future, due to a general shortage of maths teachers and the risk of having to withdraw enrichment of all kinds. The Deputy Head explains that they could save a teacher’s salary by not offering enrichments, which are currently the equivalent of almost 30 teaching periods a week. He says, “It would be a bad day, but eventually you have to make decisions sometimes you don’t want to make.” At the first fieldwork visit, there had already been a drop in classes because of funding changes, from four to three subjects in Year 12, which had a knock-on effect on staffing. There was concern as to whether this would affect teaching time further in following years, possibly resulting in teacher cuts. Priority for maths would have to be given to GCSE, Key Stages 3 and 4, and A-level Maths.

Since the Head of Maths went on initial training, the CM teachers have not had any CPD. At the first fieldwork visit, they say they would have appreciated a local network for sharing ideas and resources. They are disappointed at the lack of available resources. They rely on searching through the Integral website, but also widely utilise items from the news and from real life, which they say lead to good classroom discussions. As CM teacher 1 explains:

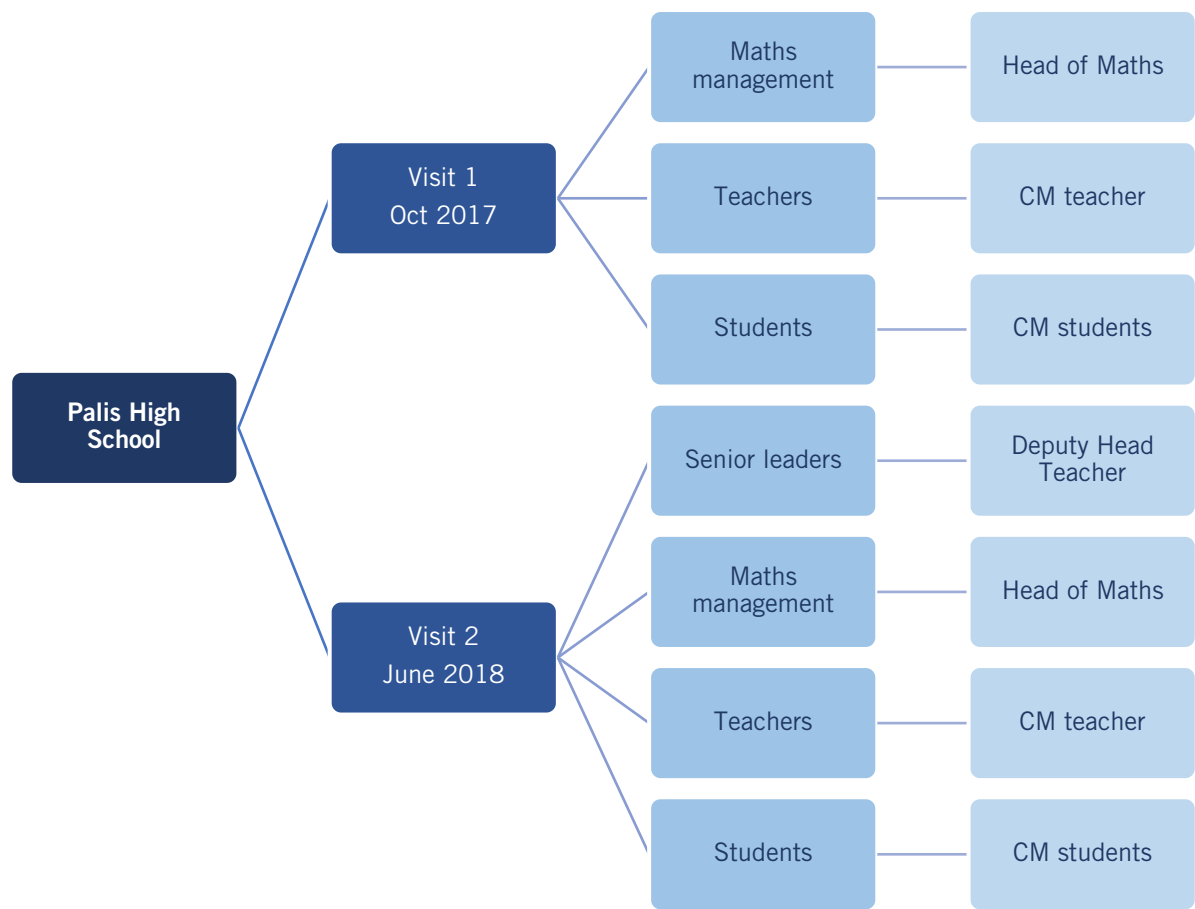
*“I think you have to, be quite a creative teacher, you know, think of ideas, and that’s what, like some teachers I know who’ve just, say like GCSE’s easy, you’re just doing this topic, you don’t need to really think about, as long as the pupils understand the concept then it’s fine but, you need to think of ideas of how to apply it to real life which it, that is time consuming in itself and, being able to get ideas from elsewhere, it’s really useful.”*

By the second visit, the two CM teachers have become more involved with the local Maths Hub, finding meetings very useful for comparing notes and sharing resources.

At the third visit, CM teacher 2 expressed how disappointed he has been at there being no Year 12 cohort this year. He is keen to recruit a group next year and has offered to teach it. In addition, he has made it part of his personal appraisal targets to promote CM within the department and the school, and to attend local CM meetings. His enthusiasm is clear:

*“I want to run the course again... I’m kind of confident we’ll get an uptake on it... I enjoy it, I absolutely do.”*

### 5.13 Palis High School



Palis High School is a single-trust academy which converted in 2011. With over 1200 pupils, it is a larger than average, oversubscribed, secondary school in an outer London borough, with majority white British pupils and a below average pupil premium proportion. Around 350 pupils are in the sixth form, often joining from other local schools. At its last full Ofsted inspection, in 2013, the school was rated *Good*. Progress and attainment are above the national average. A short inspection in 2018 rated A-level students’ progress, often from modest starting points, as above national average. A relevant piece of demographic information, according to the Head of Maths, is that:

*“...This is a sort of area of people who’ve made themselves. They’re business owners, probably, if they are living in an affluent part of this area... I mean, that’s a real over-generalisation but... you often hear the pupils talking if their parents do own their own company and they might talk about that...So some of the students do have a bit of a, a little bit of an attitude, that, you know, they know what they’re going to do when they leave school because, they can just go into the business that their parents already own, something like that.”*

Indeed, from interview data and from our student questionnaire, Palis students were the most likely to say they intended to go into employment, rather than into HE or an apprenticeship. Interview data from students and staff also gave us to understand that the proximity to London was an attractive prospect, enticing students into the financial or banking sector straight from school.

Teaching of CM began in 2015. The Head of Maths had actively sought a maths course to offer as an alternative to A-level, so that any student could continue with maths. He expresses frustration at the annual situation of turning away pupils from A-level Maths because of their GCSE grade. A particular observation about Palis is the greater

frequency with which the topic of parents arises in interviews. The Head of Maths describes parents' expectations that their child will study A-level Maths, their complaints to the school when their child is not accepted onto the course because of their GCSE result, and his own strenuous resistance of pressure to accept such individuals. Similarly, the CM teacher describes parents' strong views about what A-levels their child should do, which results in some students enrolling onto A-level Maths, not because they have any interest in it, but because their parents expect it; these can be the students who later struggle. Recognising that "who you get as your maths teacher makes a world of difference", the Head of Maths also says that parents phone the school asking that their child's allocated maths teacher be changed, describing the situation as being "like X Factor".

The Head of Maths taught CM at first, then passed it to a new member of staff who does not teach A-level, to develop that teacher's Level 3 experience, making sure that he felt comfortable and supported in delivering the new course. They are not part of a network and have had no Core Maths training or contact with the Maths Hub. The Head of Maths says that whilst the number of students is small, the enterprise is "quite self-contained"; with a larger class, he might explore meeting other schools and discussing best practice.

The CM teacher tells us that he makes a lot of his own resources, taking things from the news, getting content using, for example, RightMove, football statistics, car insurance (Direct Line), and says he has his ears open "massively":

*"I'm trying, every single time we do something I get the content, content, content, and then we relate it back and say like, oh here's the Premier League table and, oh here's a golf result or, here is, we did the thing of um, social housing and, new housing..."*

In the first year of CM, six students who had wanted to do A-level Maths, but who did not have the requisite access grades, took CM, offered, as a last-minute addition to the timetable, as an after-school session. This was not ideal, and only two students carried on into Year 13 to complete the course, both achieving an A grade. In the second year, CM was timetabled within the normal school day. Staff interviewed said they very much wanted the numbers to grow. The CM teacher describes the maths department as "really, really strong" and relationships with the pupils as "really, really good." As with Lions Academy (q.v.), a good maths team is linked with students' positive attitudes towards the subject.

Senior leaders agreed to offer the course over two years, lessening the cost implications: staffing two hours per week is less of a burden than the four hours a week allocated to A-levels. As the Head of Maths explains, "I think we've snuck in there at just two hours from the timetable a week." He is confident that the school has committed to the course, as long as there are students wanting to take it; however, he does also say that Further Maths was withdrawn fairly recently when there were not enough students to make it viable, and that the number of BTEC courses offered has recently been reduced because of funding pressures.

Palis offers the Edexcel specification. The Head of Maths felt comfortable with Edexcel, whose A-level Maths specification they also use. Uniquely amongst our case studies, here the CM qualification is referred to by its official title, "Maths in Context", as opposed to "Core Maths", and the Head of Maths explains why:

*"I know Core Maths is sort of the umbrella term for this type of course. No, ours is definitely the Maths in Context course. Which is a great title, isn't it, 'cause that tells you what it is!"*

There have been fewer than ten students in each year group, generally achieving GCSE Maths grades 5 and 6. The perception is that Foundation students with grade 5 can access CM. The Core Maths teacher tells us "they are OK at maths but they're not, some of them aren't the greatest, at maths." Students take CM as an extra course beyond their three-subject study programme. A minority of students take CM as one of three options, possibly combined with the EPQ; these students are made aware that they will be restricted to applying to points-based HE courses. The Head of Maths explains:

*“...The aim for all students now here is that they take three A-levels, and the Core Maths is offered as an option extra to three other A-levels....There are some students who are allowed on, um, based on the criteria of when they're enrolled in the sixth form onto two and the Core Maths, um, but obviously those students need to be, you know, have to be made fully aware at the beginning, you know, we're absolutely full on that it is, you know, it's not worth three A-levels if they do that.”*

Ideally, CM would be marketed to students as a positive addition to their programme, but such recruitment is tricky, as the Head of Maths explains:

*“ I think it would be quite a hard sell to a student if they were really fixed on their three A-levels, either three sciences, or maybe they're an Economics, Business, Psychology, I don't know, another three, it would be a hard sell at this school, to take that extra, if, if students didn't feel that it automatically benefited them... 'Cause if they've got three A-levels and they can get into uni with those three A-levels, they can worry about the maths another time, can't they... You're asking the students to do something extra than what they actually need, to go to university. And even though it benefits them, they might think well I've got enough on my plate already, with three A-levels. You know, whether or not that's, that's helpful to do that as well, it's, it's an extra thing isn't it to, to have to study.”*

Some students opt into CM after what the school calls the “drop-down day”, when Year 11 experience Level 3 taster lessons in different subjects. Also, as most students are known to maths staff who have taught them through Key Stages 3 and 4, staff can target them and talk to them about CM in advance. The Head of Maths does recognise that enrolment onto CM is currently rather a default negative: the course is actively promoted to those who want to study maths post-16, but who cannot access A-level Maths, so enrol onto CM instead. A-level and CM are timetabled simultaneously, and students do move out of A-level and into CM. The school only makes AS entries in circumstances where students look unlikely to reach the end of the second year successfully, in which case they can take an AS and withdraw from the subject. This does sometimes happen with students withdrawing from A-level Maths, and they may join the CM class in Year 13. The metaphor of ‘dropping down’ occurs most frequently amongst staff at Palis, indicating how explicitly this hierarchy is felt at the school. As the Core Maths teacher explains:

*“some people struggle, with the A, AS and, drop down...”*

The Head of Maths equally uses the metaphor:

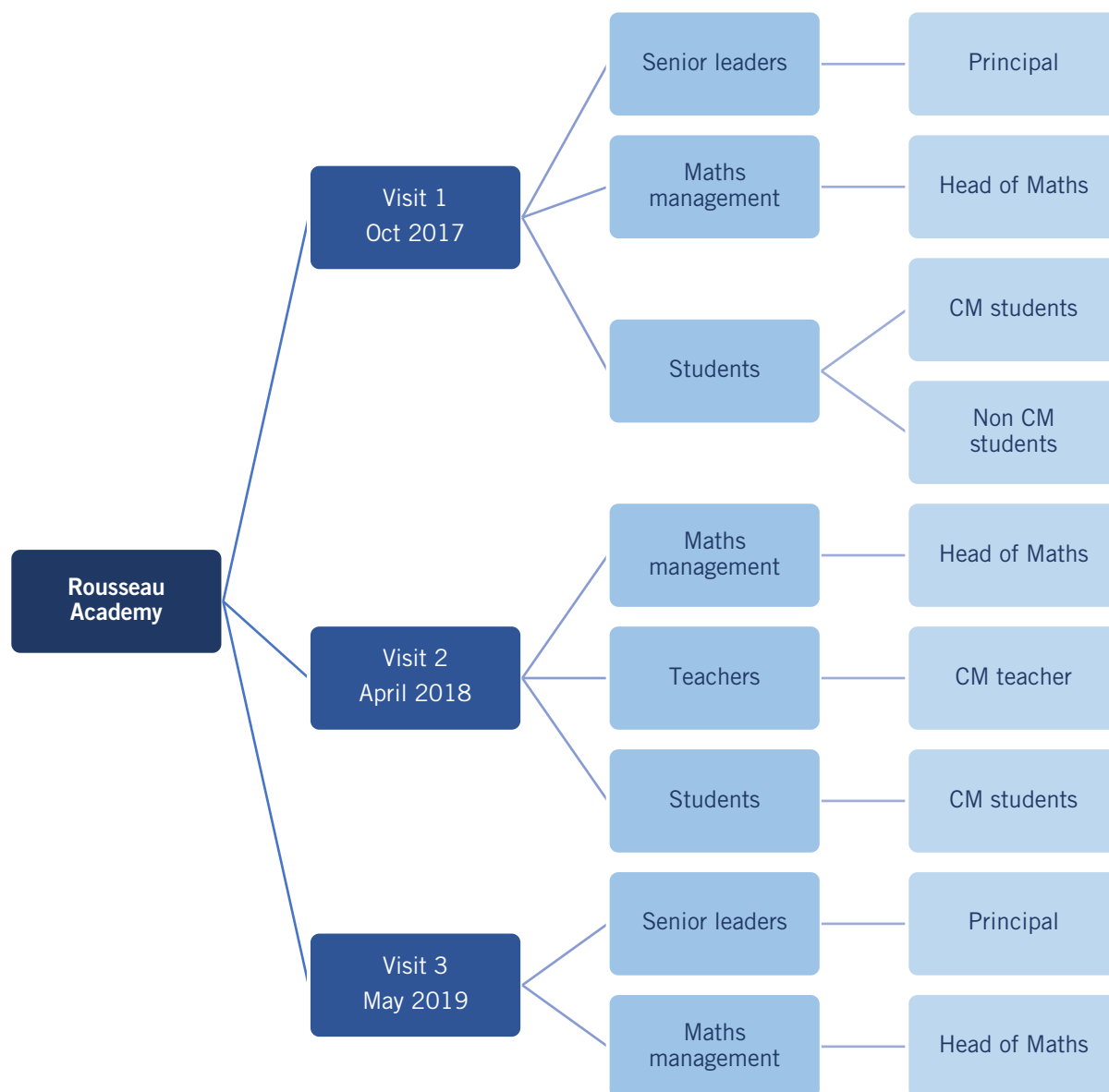
*“some of them [the students] dropped back down to Core Maths...”*

Despite the sense of hierarchy, CM is valued as an opportunity to study maths post-16. The Core Maths teacher explains why:

*“ I think it's a really good bridge, for, maths going into work, life, definitely 100%, and I just think it needs to be a bit more promoted, within the school or, maybe, I don't know, round different schools, because, there's not much of an uptake on it, but I've really enjoyed teaching it. The kids seem to have really enjoyed what we're doing. They're always asking questions about different things.”*

We did not manage to visit Palis for a third time. The third visit, arranged in May 2019, was cancelled at the last minute due to an unforeseen diary clash, and proved impossible to reschedule. Our initial contact there, the Head of Maths who had agreed to participate in the study, had left to take up a post elsewhere, leaving the CM teacher to be our subsequent contact. This teacher, who had been willing to speak to us during the first two rounds of fieldwork and seemed engaged with the study, did not respond to several attempts at contact, finally responding at a time where the researcher's calendar was very tight. Unfortunately it was also the school which was at the greatest distance from us and therefore most time-consuming to accommodate. In the end, a proposed visit, squeezed into the diary, had to be cancelled because of other events which had to take priority. Again, attempts to contact the teacher in order to reschedule, or even speak on the phone, did not prove fruitful.

## 5.14 Rousseau Academy UTC



Rousseau Academy is one of the country's 48 University Technical Colleges (UTCs). UTCs were first introduced by the Conservative/Liberal Democrat coalition government (2010-2015) as schools specifically geared towards delivering technical education for 14-19-year-olds. All aspects of the school's learning - pastoral, academic and technical - are designed to be applicable to the workplace, and reflect the needs of the local economy. Rousseau's speciality is engineering. There are currently around 350 students, and the school is running at approximately 55% capacity. Roughly one in ten students is eligible for free school meals. Students, of whom around a quarter are girls, transfer into Year 10 from a large number of other schools. Whilst many pupils came, at first, from situations of underachieving in other schools, now pupils are coming for the specialised engineering provision.

The school was rated *Good* in 2017. Attainment is improving. Outcomes for post-16 students following vocational courses are now just above the national average. Some pupils enter the sixth form without GCSE English or Maths, but retake them and make better progress than other pupils nationally with similar starting points. In 2019, completion and attainment for technical qualifications were above average; for academic qualifications, progress was above average, but completion below average. However, retention is improving, and, before joining the sixth form, students receive guidance which better takes prior attainment and aspirations into account, and study programmes are well matched to student need.

As a new school, opening in 2014, the curriculum was set up from scratch. The Principal was keen to offer a maths qualification for students unable to access Maths A-level. He was aware that "it's a customers game, effectively" and he did not want to lose any "customers" - those with a B at GCSE who wanted or needed to do some maths at Level 3. They found out about CM on the internet, offering it first in 2015. Rousseau chose to offer the AQA specification with Paper 2B (Critical path and risk analysis) to link with engineering. According to the Principal, AQA were known to be quick off the mark with resources for new qualifications; he believes many schools chose AQA for CM for that reason. The course was set up to run over two years, to have the same sense of being a "long haul" (Principal) course like an A-level. Three hours per week were allocated to CM, compared with five hours for an A-level.

Between the Head of Maths responding positively in summer 2017 to an invitation to take part in our research, and the time of our first fieldwork visit in autumn 2017, the decision had already been taken to withdraw CM. Results in 2017 had been Cs, Ds and Es, and of the 2016 cohort only six students progressed into Year 13. In a climate where retention, as well as attainment, is measured, completion rates affect funding. The Principal explains the decision not to recruit a Year 12 cohort:

*"The results were, disappointing, and the drop off, in terms of the numbers, there's also a, a question mark around the financial viability of the smaller and increasingly smaller groups...We really do believe in the principle of it, but I've gotta answer those two issues. One is the financial viability of group sizes, and one is results. How we get those better."*

The Principal described the pressure felt by the 14-19 sector of supporting relatively small post-16 groups. He compared the school with 11-18 institutions which can cross-subsidise small post-16 groups because of large Key Stage 3 and 4 groups. In addition, they are a small school in the first place, giving them a small pool of potential students to draw from.

From the start, the UTC considered CM as an alternative to A-level, for students who wanted to take A-level but could not access it. However, it was positioned as a fourth option, with students taking three two-year courses or equivalent, plus CM. Some students did withdraw from one of their two-year courses at the end of the first year, leaving them with only two courses plus CM, in which case they might pick up an EPQ to recover some UCAS points.

The Head of Maths explained that students saw CM as low status, being the equivalent of an AS, in a context where AS courses were no longer being offered:

*"I think, that made them think well, that's basically an AS then, and we're not doing AS. So we're not doing it...They don't rate it, as highly as other courses that they do, they see it as dispensable."*

The management continued to think about ways in which they could reintroduce CM successfully. In particular, they

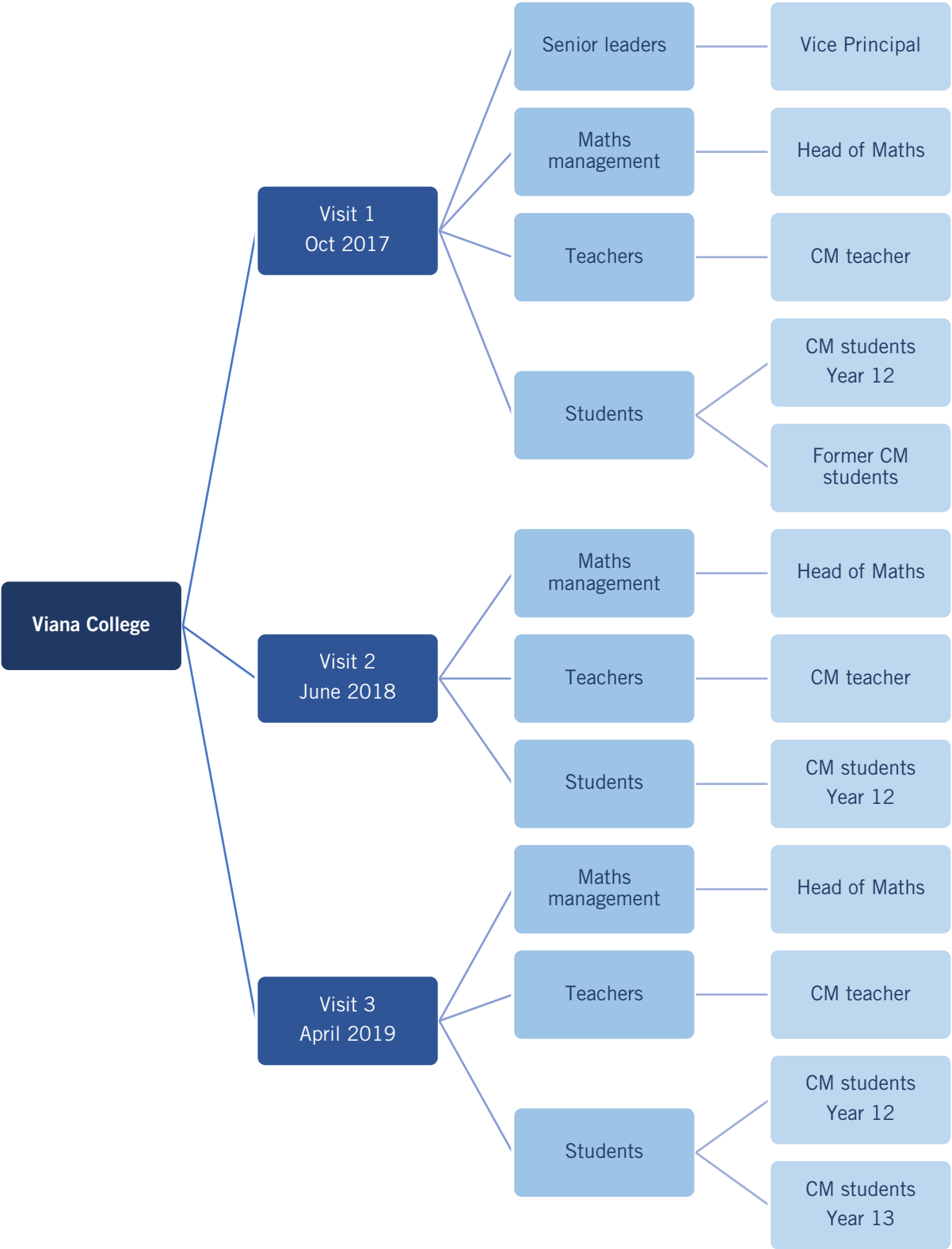
considered how they might block CM as part of a package with other qualifications, making CM more or less compulsory, or incorporate it into study programmes so that students would complete the CM substance as part of their programme and then simply take the exam, almost unaware that they were doing anything extra.

On visiting Rousseau in the summer of 2019, we learned of the plan to reintroduce CM in autumn 2019, timetabling it in an enrichment/further study block, in addition to three courses (or equivalent). The Principal tells us they are missing having a maths option for the students who cannot access A-level. They recognise the usefulness of the applied nature of CM, its support for the maths in other subjects, and the fact that it is good to keep maths going in the sixth form. In fact, the Head of Maths tells us that keeping maths going is more of a priority for them than trying to match particular options to the maths in other subjects.

The Principal also believes there has been a shift in attitudes from HE, to a greater focus on breadth of post-16 study, looking positively on students who include maths in their programme. The Principal, who told us at the first fieldwork visit that one of his first questions on choosing whether to offer a qualification was “Do they [HE] take it?” also says he is becoming less nervous about whether universities will accept particular qualifications. He is more and more convinced that the school should offer what they think is right for their students. In addition, from his experience working with local employers, he believes employers do not recognise or understand any maths qualifications beyond A-level Maths. They do not understand BTEC and they do not understand CM. The Principal believes that employers should be recognising and accepting a range of post-16 maths routes, and that CM should be part of that. He also believes that Ofsted are moving towards recognising the use value of a course, rather than just the exchange value of a qualification.



5.15 Viana Sixth Form College



Viana Sixth Form College is situated in a city with a population of over half a million in the North West of England. Around a third of the population are from BAME backgrounds. Over a thousand 16 to 19 students, from the city and the surrounding area, are enrolled at Viana, mostly studying a wide range of A-levels; around one in ten is enrolled on applied general qualifications (BTECs). The college was rated *Outstanding* at its last inspection, in 2008; the last Ofsted curriculum and development visit was in 2012. No more recent demographic information is available.

The college offers A-levels in Maths, Further Maths and Statistics. In 2017-18, just under 200 students were in their first year of A-level Maths, around 20 were taking the first year of A-level Statistics, and just under 40 were in the first year of Further Maths. Roughly 50 students enrolled on CM in 2017. In 2018-19, over 70 students were in the first year of CM, in four groups, and around 30 of 50 who had begun year 1 were continuing into year 2.

Viana started teaching CM in 2015 as an Early Developer. With that status, the Head of Maths tells us, a substantial amount of money came to the college. CM filled a gap where there was no post-16 maths option for GCSE B and C grade (now grades 4, 5 and 6) students. Initially, Core Maths was taught over one year, fitting in with the model whereby students generally started their post-16 programme with four subjects, knowing that they would cash one in and move into the second year with three. Between 25 and 30 students opted into CM each year in 2015 and 2016, knowing it was a one-year option.

With funding and curriculum changes, the college moved, as did others, to a model of three subjects across first and second year, examined only at the end of the second year. The position of Core Maths had to be reconsidered, as the Head of Maths explains:

*“...for the students, what point was there for them to study a course which didn't lead into a second year now that everything was moving to a two-year linear model?... there was no second year studying it, which is the big problem with Core Maths in terms of selling it... We wanted to keep this course, 'cause we did think, we like it, we think it's a good course and it's, it's an alternative approach to maths which actually, it's more suitable for the majority of our students if they want to study maths. But, we were struggling to work out how to keep it... With linearity coming along, there's a problem with how we fit it in. There's no funding for it. The college gets no, there's no incentive for the college to deliver it, because our directed hours are sufficient without that additional course.”*

College policy was that CM could not be one of three main courses, since it did not lead into a second year, and a new justification had to be made for continuing to offer CM. The Vice Principal explains how the decision was made to position CM as an additional course:

*“As we were moving two or three years ago from modular to linear A-levels, we began to wonder how we might use a Core Maths qualification integrated into a larger programme of study... Our programmes of study, essentially is a core of three A-levels, it's the option of doing an EPQ, an Extended Project Qualification, it's Core Maths, and it's curriculum enrichment beyond that...”*

From 2017, therefore, CM would be offered over two years, explicitly as a support course: students wishing to study subjects such as Psychology or Biology which ask for GCSE Maths grade 5, but who only have grade 4, can enrol onto those subjects if they also enrol on Core Maths.

Alternatively, students can opt into CM as an extension course running alongside students' main study programme. The Extended Project Qualification (EPQ) is another extension option, attracting around 100 students each year. Again, the Vice Principal explains:

*“We're very, very keen to give opportunities to students, but also, for many, to direct, for them to understand that we're doing things for their benefit... if we want to make students successful, we do need to keep them busy in the absence of four A-levels, where we were, and we do need to provide additionality wherever possible. Core Maths is just one of those.”*

The Vice Principal believes that students can manage the course as an extra, over two years. He encapsulates what we heard across our case study institutions, by describing the balance between the extra investment from the college, and the benefits to students:

*“I think, it’s an investment, from institutions, and I think we’ve had to invest staffing and time and effort into it, and of course, if we didn’t offer it, there would be a saving there... but we see that there’s enough benefit from doing that, for us to do it.”*

Equally, the Head of Maths acknowledges wider staffing problems, as he explains:

*“With the funding issues, I know a lot of people have just not bothered doing it, because why?! You know, you’ve got maths specialist teachers difficult to find, so, so why offer an additional course using their time if you haven’t got that resource either.”*

Viana are teaching AQA with Paper 2A (Statistical techniques), supporting subjects with statistical content. This option was the preference of the first of the college’s Core Maths teachers, who also teach statistics within Maths A-level. At the start of 2017-18, there was a plan to group CM students according to their other subjects, and to offer Business Studies students the Critical path analysis option. This did not transpire, due to problems enrolling the appropriate students onto CM. As the Head of Maths explained, other subject teachers are relied on to guide students onto CM at enrolment, and poor communication, possibly coupled with lack of staff engagement and awareness, means that this does not always work efficiently.

As Core Maths is explicitly positioned at Viana as a support course, the main CM teacher has gone to some lengths to liaise with the Psychology teacher particularly, to find out what mathematical or quantitative skills are in the Psychology course and when they are taught, to try and dovetail the CM content with it. Students do not always recognise those links, however. They are often resentful, in fact, of being obliged (“forced”, they say) to take maths, particularly if they believed they would never have to take maths again having secured their GCSE grade 4. This leads to a problem with retention: students withdraw from Core Maths, seeing their friends taking three subjects and having more free time, but also responding to what they see as an inconsistency in college policy, observing that some students in the same position as them - with a lower GCSE Maths grade than the usual access grade for Psychology, Biology and other subjects - were not caught in the net at the start and were not enrolled, as they were, on the CM course.

There are two lessons per week, totalling two-and-a-quarter hours of teaching time a week, and the maths staff are resisting a reorganisation of the timetable where this changes to one lesson of two-and-a-quarter hours, because they would only see the students once a week. According to the Vice Principal, “our best frontline teachers... teachers with energy and enthusiasm that are gonna work at doing it” are allocated to the teaching of CM because “they’re gonna be delivering it to non-maths specialists, and to students who, some of whom might not be as motivated to succeed on that.” The CM teacher tells us that early on she went on training courses run by the CMSP. One of the area co-ordinators for the AMSP is now based at and teaches at the college; the Head of Maths applied for the college to host the role, believing that it would be a good asset for the college.

Students rarely swap from A-level Maths to CM at Viana, because this would compromise their three full courses; they sometimes swap to A-level Statistics, instead, but there is a resistance to this because of the kudos of A-level Maths, and also perhaps - the Head of Maths and CM teacher agree - a sense of admitting failure. Students are more likely to drop CM than one of their two-year courses, if they are struggling with workload. Those few students who do drop a full course, leaving two full qualifications plus CM, may take on the EPQ to make up their UCAS points.

In 2019, at the third round of fieldwork, the Vice Principal spoke positively about the expansion of CM at Viana, and its prospects. He described the determination of the CM staff and Head of Maths to drive the flourishing of CM, hoping that the college was influential to other colleges in the area, and also hoping that the qualification succeeds nationally, because of the importance of improving maths skills. The Head of Maths expresses a concern that this new qualification might suffer the same fate as Use of Maths did:

*“...certain elite university maths professors, basically publicly slated Use of Maths, without a recognition that maybe not all students doing maths post-16 would go and do degrees in Maths... and we were concerned that Core Maths might suffer the same fate.”*

The Vice Principal acknowledges that the college is still working on how to get the right students onto the course, describing it as “still finding our way”. He wonders whether the course is being oversold in terms of supporting other subjects, and not sold enough on its own merits, as an opportunity to continue and develop maths for its own sake. He wants to build this in the future, promoting it, for example, to arts and humanities students in order to broaden their study programme. In addition, he still has concerns that CM is being targeted mainly at lower achievers, and would like some of the higher achievers (“top students who aren’t top at maths”), who currently opt into the EPQ, to opt into CM. The Head of Maths has a concern, however, that if students opt into CM as an extra course, there is nothing to stop them from dropping it when they find it is too much or realise it may not count towards their HE application.

Viana is the only one of our case study institutions which benefited by design from the Advanced Maths Premium, calculating that they would be able to pay for an extra maths teacher if they recruited a particular number of students, and have indeed managed to do so. Government data for 2018-19<sup>59</sup> show that Viana SF College received substantial amounts of AMP funding.

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<sup>59</sup> See <https://www.gov.uk/government/publications/16-to-19-allocation-data-2019-to-2020-academic-year/16-to-19-funding-allocations-2019-to-2020-academic-year>.

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## 7 Appendix

The separate Appendix zip file contains details of the online survey (questions, anonymised summary responses and survey structure), an example of the quantitative questionnaire given to CM students in case study institutions, and a list of interviewed stakeholders.

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