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“Core Maths chooses you; you don’t choose Core Maths.” The positioning of a new mathematics course within the post-16 curriculum in England.

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“Core Maths chooses you; you don’t choose Core Maths.” The positioning of a new mathematics course within the post-16 curriculum in England.

A recent government move to increase numbers of students taking post-16 (post-compulsory) mathematics in England saw 2,930 students being awarded the first Core Maths qualifications in 2016, the number rising to 9,027 in 2019. This paper uses qualitative data, from a study investigating the successes and challenges of these new qualifications in their initial period of implementation, to explore perspectives on how the new qualification is being positioned within the existing post-16 curriculum structure. First- and second-order effects of the policy are considered, particularly in relation to the dichotomy between Core Maths and the longstanding, highly academic, A-level Mathematics. Our findings reveal a positive regard for many aspects of Core Maths. However, the systemic processes by which certain students are manoeuvred onto the Core Maths course, and the resulting opportunities for progression of those students, could be interpreted as restrictive, despite the benefits for students of new opportunities for pursuing mathematics study.

Keywords: post-16 mathematics; post-16 education policy; Core Maths

Introduction

This article focuses on one aspect of the findings from a study investigating the enactment of a government policy to increase participation in post-16 mathematics in England with a set of qualifications collectively known as Core Maths (CM) (Department for Education, 2013). The broader research project has several quantitative and qualitative strands, which will together provide a picture of the successes and challenges of these new qualifications.

In this paper, we use qualitative data, collected from case study institutions in autumn 2017, to address the research question:

> What can we learn about curriculum policy enactment from looking at the positioning of CM as it is introduced into schools and colleges in England?

The intention here is not to attempt an assessment of, nor to predict, the success or otherwise of the Core Maths initiative. The paper presents case study data on how CM is being incorporated within the broader curriculum context, for some students wishing to study mathematics post-16. It illustrates how access to and participation in CM reflect its positioning within an institution's curriculum offer, particularly in relation to the long-established, highly regarded, Mathematics A-level,[i] and within students' individual programmes.

We consider the policy in the light of its original intentions or first-order effects (Bowe et al., 1992), and find unintended consequences, or second-order effects, in terms of implications for students' further progression. Policy is not translated into practice in observable, measurable steps, in rational, linear fashion, but enacted in complex, contingent ways (Bowe et al., 1992). Research should examine how policy is realised according to its own goals, its first-order effects; but it should also acknowledge unintended outcomes, or second-order effects, particularly in terms of social justice (Bowe et al., 1992; Lingard & Sellar, 2013). Accordingly, this paper explores some of the consequences of the institutional positioning of CM, taking particular account of the post-compulsory phase's historical role in preparing students for Higher Education (HE) (Phillips & Pound, 2003).

Historical and policy context

It is important to describe the curriculum context into which CM was introduced, in order to explain why new mathematics qualifications were deemed necessary, and to understand how institutions might position (target, brand and promote) CM in relation to their existing curriculum offer. We outline some of the background relevant to post-16 curriculum provision and mathematics curriculum innovation, and briefly identify the original aims

and intentions of CM.[ii]

The post-16 curriculum in England

The GCSE[iii] examinations are a transition point, beyond which students continuing into post-16 education take a reduced number of subjects, typically three, from among the options available. The narrow range of subjects studied post-16 in England, and in Wales and Northern Ireland, is unusual within the Organisation for Economic Co-operation and Development, where some mathematics is generally studied, often as part of a broad baccalaureate-type curriculum (Hodgen et al., 2010). Debates over the contemporary relevance of GCSEs, the age of 16 as a transition point, and the perceived narrowness of the post-16 curriculum, whilst important, are not the focus here. However, we do consider briefly the notion of 'choice'.

Students' freedom to make choices is constrained by multiple factors within complex structures, including budget, staff expertise, and the social and cultural capital of institutions themselves, resulting in differential access to subjects and qualifications (Abrahams, 2018). Importantly, 'choice' at every transition point in the English education system entails, in practice, segregation according to relative success or failure at the previous stage (Hodgson & Spours, 2004; Phillips & Pound, 2003). Transition from one educational phase to the next is a process of selection (including self-selection), not merely of progression. Access to post-16 courses depends on prior attainment, endowing GCSEs with a gatekeeping role in limiting or opening post-16 opportunities (Cornish, 2017; Dilnot, 2016). It is known that stratification by prior attainment is, to an extent, stratification by socioeconomic status (Abrahams, 2018; Moulton et al., 2018). Young people from disadvantaged backgrounds achieve at lower levels throughout schooling (E. Smith & Gorard, 2011), so, on average, GCSE success reflects inequalities in SES and students' pre-16 opportunities (Abrahams, 2018; Dilnot, 2016). Students' own sense of

likely success also results in self-exclusion from options considered not for the likes of them (Abrahams, 2018; Reay, 2012).

The exclusivity of A-level Mathematics

Selection is especially pertinent in the case of A-level Mathematics, widely perceived as difficult (Rigby, 2017), and only for the very clever and elite (Brown, Brown, & Bibby, 2008). Historically, the GCSE to A-level transition has been problematic, with mathematics suffering the most withdrawals prior to the examinations (Rigby, 2017). Consequently, though policies vary (Noyes, 2013), institutions typically only allow students with the highest prior attainment (e.g. GCSE grade A/A*, now 7/8/9) onto the course (Noyes & Adkins, 2016). Students with GCSE grade B/6 are not necessarily seen as well equipped for A-level Mathematics (Brown et al., 2008), although in other subjects grade B/6, or even 5, would permit access to advanced-level courses. These strict access policies result in clearly skewed grades compared with other subjects. In 2018, for example, 42.2% of students achieved A*/A grades in A-level Mathematics, compared to 26.4% for all A-level subjects (Nye & Thompson, 2018).

A-level Mathematics is therefore perceived as relatively exclusive (British Academy, 2016; Brown et al., 2008; Noyes, Drake, Wake, & Murphy, 2011), despite being the most popular A-level in England. In 2018, there were 90,198 entries (Joint Council for Qualifications, 2018), well ahead of Biology, second in popularity with 58,179 entries. A-level Mathematics is seen increasingly as the ultimate door-opener to both HE and careers (Morgan, 2014; Taylor, 2014). The advantage of having A-level Mathematics outstrips the advantages of having A-levels at all: of all post-16 qualifications, A-level Mathematics has the greatest exchange value (Dilnot, 2016), which has been sustained over time (Noyes & Adkins, 2017), perhaps simply in possessing the qualification rather than in any

mathematical or other skills developed through studying it. Students with Mathematics A-level are much more likely than others to enter highly-ranked universities, whether to study Mathematics or another subject (Dilnot, 2018). Economic arguments repeatedly assert that students with A-level Mathematics will earn 10% more over their lifetime (Adkins & Noyes, 2016; Dolton & Vignoles, 2002; Kounine et al., 2008; Morgan, 2014).

The combination of desirability and exclusiveness has therefore lent the qualification a special status. Students denied access to, or excluding themselves from, A-level Mathematics miss out not only on the qualification itself, but also on the benefits afforded in terms of signalling and future opportunities, such as access to high status universities and lucrative employment.

The maths gap

In most centres, A-level Mathematics has been the standard post-GCSE Level 3 (advanced or pre-university level) mathematics offer. The high access grade, however, has precluded many students from taking it. There has long been concern, particularly among the mathematics education community (A. Smith, 2004), that post-compulsory mathematics options are too limited. Each year, over 200,000 students in England (around 40% of the cohort) stop studying mathematics after GCSE (Department for Education, 2013): they have secured at least grade C/4 in GCSE Mathematics, below which students find themselves obliged to resit, but they do not enrol for A-level Mathematics. The only other real option, offered in relatively few institutions, but liked by those who taught or studied it, has been Use of Mathematics,[iv] available at AS[v] and (with pilot status) at A-level over a decade, and now withdrawn.

This deficit in Level 3 mathematics provision, for those neither taking A-level Mathematics nor resitting GCSE Mathematics, resulted in the term “maths gap”

(Department for Education, 2014a, para.9). In other documentation (Department for Education, 2013), "gap" refers to the period between GCSE and university or employment, during which time students' mathematical skills and knowledge are thought liable to deteriorate if neglected. CM qualifications were developed (Department for Education, 2015) in an attempt to address both these perceived gaps.

Core Maths

Core Maths is intentionally different in nature from A-level Mathematics. A-level is intended to prepare students for higher study with significant mathematical focus, developing advanced analysis of mathematical problems, calculus, and construction of related arguments and methods of proof; Core Maths introduces relatively little new content, employing knowledge and skills learned at GCSE in problem solving and contextual quantitative and mathematical activities (Department for Education, 2013) including where there might not be one 'right' answer. It supports other subjects studied concurrently (e.g. Psychology, Geography), and prepares students for further study in various subjects from Biology to Business, or for employment and life (Department for Education, 2015). The titles of CM qualifications offered by the three main English awarding bodies allude to these aims: Pearson Edexcel's *Certificate in Mathematics in Context*; AQA's *Level 3 Certificate in Mathematical Studies*; and OCR/MEI's alternatives of *Quantitative Reasoning* or *Quantitative Problem Solving*.[vi]

Core Maths within the post-16 funding framework

The post-16 sector in England is now characterised by a curriculum and funding framework in which study programmes are based around three two-year linear courses (e.g. A-levels) or the equivalent (e.g. BTEC[vii] qualifications). Standard 16-19 funding covers an annual programme of 540 hours, or 3 x 180 hours per year (Education and Skills

Funding Agency, 2017). For Core Maths, half the total teaching time is prescribed compared with an A-level (180 compared to 360 hours). CM was intended for delivery over two years to ensure ongoing mathematics study alongside a Level 3 programme (Department for Education, 2013), but it can be completed in one year. In terms of expected standard, CM is equivalent to AS-level, halfway towards A-level.

The peculiarity of Core Maths, as essentially a one-year course, or a half-sized two-year course, means that it does not easily fit into this structure. One of the biggest challenges for centres is therefore how to position Core Maths within the curriculum. Their decisions will influence which students take up this new qualification.

Applied qualifications

One final factor to keep in mind as we examine our data is the academic-vocational divide. The English education system can be seen as camouflaging a two-tier system which segregates students, including channelling them into different types of institution. A powerful academic/vocational stratification, with students streamed into vocational routes positioned as less worthy than courses based on abstract and theoretical learning, was already being discussed four decades ago (Bowles & Gintis, 1976). Couched in the rhetoric of choice, of differentiation according to student need, students are excluded from particular options. Certain groups, especially students from the poorest socio-economic groups, are disadvantaged (Abrahams, 2018; Jerrim, Greany, & Perera, 2018; Reay, 2012). Courses with a vocational or applied orientation, which were meant to broaden students' options, have suffered from low status. Rather than expanding options, students taking vocational qualifications may find their future opportunities restricted (Bell & Donnelly, 2006; Moulton et al., 2018). Differences in outcomes are accepted, and disadvantage portrayed as the fault of individuals or schools, rather than the system itself (Reay 2007;

2012).

A-levels, introduced in 1949 as a university entrance mechanism (Phillips & Pound, 2003), are still perceived as the 'gold standard' (Noyes, Wake, et al., 2011) amongst the different post-16 qualification types. Alternative, applied, qualifications exist in a number of subjects. For example, both BTECs and A-levels are available in sciences, law and music; the lower status of the applied qualification is exacerbated by the competing, more dominant, academic qualification in the subject. Now, alongside A-level Mathematics, is Core Maths, which, since it focuses on mathematical applications in context, could be described as an applied qualification. The duality of the two qualifications is even more exaggerated because of the high status of A-level Mathematics.

Beyond examining how or whether CM addresses the stated aims of increasing and broadening post-16 mathematics participation, insights into the policy's second-order effects will complement descriptions of institutional practices with an assessment of their underlying implications. Interrogation is needed of restrictions within the education system, such as access to the prestigious A-level Mathematics, penetrating the rhetoric of choice and discovering a social order, a hierarchy, based on cultural capital and differential access (Bourdieu, 1984).

Methodology

Our three-year, mixed-methods study includes several strands: analysis of national pupil data from 2016 to 2018; student questionnaire data relating to dispositions towards mathematics; an online survey to mathematics teachers and maths education professional bodies; and qualitative work with teachers, managers, students, and other stakeholders such as Higher Education Institution (HEI) admissions tutors and employers. This paper is based on data collected in autumn 2017 from thirteen case study post-16 centres in

England. Semi-structured interviews were conducted with 15 CM teachers, twelve Heads of Mathematics, and eleven senior leaders (Principals/Headteachers/Deputy Headteachers/Heads of Faculty). Interviews covered relevant issues identified from the literature, such as transitions to post-16 mathematics, staff expertise, and the content and approach of CM, but also allowed participants to talk broadly about experiences of and perspectives on mathematics education. Senior leaders were also able to discuss CM's place in the wider curriculum context. Interviews were also conducted with 62 students who were new to the CM course, nine who had completed CM the previous year, and 16 who were not studying CM. Students were asked about, for example, their motivations for studying CM, what other subjects they were studying, and what they were intending to do post-18. As CM was a new qualification, there was no literature about student responses to the course, though our interviews were informed by wider knowledge of student dispositions towards mathematics and issues of post-16 maths (and broader) participation.

All interviews were transcribed, and coded using the software package NVivo 11. The coding framework reflected the interview schedules, thus incorporating issues from the literature and policy, but also captured issues emerging from the interviews themselves. Separate codeframes were created for students and for staff, though there were commonalities. Staff data was grouped into eleven primary-level codes, covering such themes as *curriculum*, *networks*, and *CM marketing*; each of the eleven was subdivided, and mostly subdivided again, into more detailed and specific themes. For example, the *Networks* code was subdivided into *Maths Hubs*, *CMSP*, *teacher networks beyond school*, *other*. Similarly, student data produced five primary codes (*future plans*, *previous experiences of maths*, *reasons for doing CM*, *study programme*, *CM itself*) which were themselves subdivided. For example, in the student codeframe, the primary code *Reasons*

for doing CM was subdivided into *A-level Maths too hard*, *had to do it*, *interest/enjoyment*, *supports other subjects*, *useful for everyday life*, *useful for progression*, *other*.

As coding and analysis proceeded, it became apparent that the status of CM, particularly in relation to A-level Maths, was emerging as a theme across a number of both staff and student codes, as were themes of choice and restriction. Within the student codes, these themes crossed the codes *future plans*, study programme and reasons for doing CM, and seemed particularly prominent. Equally, among the staff codes, themes were emerging relating to the distinction between A-level Maths and CM, and to the enrolment of different student groups on these courses. In the case of both staff and students, the theme of how CM is positioned within student study programmes crossed with themes of choice and restriction, progression and opportunity.

In this paper, then, we report findings on these themes. In reporting, pseudonyms (Table 1) are allocated to the case study centres, using names of recent presidents and vice presidents of the International Mathematical Union. The part of each institution's name indicating its type (Sixth Form College, Comprehensive School etc.) is retained.

Case study institutions	Type/location in England	Core Maths specification/duration
Ball Comprehensive School	11-18 school, North East	AQA, two years
Bismut Academy	11-18 school, East Midlands	OCR, one year
Donaldson High School	11-18 school, West Midlands	AQA, two years
Lions Academy	11-18 school, East Midlands	OCR, one year
Mumford High School	11-18 school, Yorkshire & Humberside	OCR, two years
Palis High School	11-18 school, London & South East	Edexcel, two years
Coates Studio	14-19 studio school, North West	AQA, one year
Rousseau UTC	14-19 University Technical College, West Midlands	AQA, two years
Arnold College	General Further Education college, West Midlands	AQA, one year
Jones College	General Further Education college, North West	AQA, one-two years
Dickenstein SFC	Sixth Form College (16-19), Yorkshire & Humberside	OCR, one year
Mori SFC	Sixth Form College (16-19), North East	Edexcel, one year
Viana SFC	Sixth Form College (16-19), North West	AQA, two years

Table 1: Participating institutions (pseudonyms) and geographical location, type, awarding body, length of course

Opportunity

Students and staff welcome CM as an opportunity to study mathematics alongside a main 540-hour, three-subject (or equivalent) study programme. CM is often, as was intended, positioned and marketed as an enrichment or extension course, into which any student can opt.

Teachers and senior leaders acknowledge the longstanding need for another post-16 mathematics qualification besides A-level, often speaking of an “alternative to A-level” or an “alternative pathway”. References in the literature to the “maths gap” are echoed in participants’ use of ‘gap’ and ‘hole’ metaphors. Bismut’s Assistant Principal considers that CM has a “big role to play for anybody that wants to continue doing maths”, because it has filled a “gaping hole” between A-level Mathematics and the GCSE Mathematics resit.

Participants also use the second sense of "gap" (across time). One student comments that "GCSE is a long way back now, and with CM it just keeps it going, keeps it jogging my memory". Dickenstein's CM teacher is aware that:

> …universities were noticing, the lack of mathematical skill, students leaving school, not doing any maths till they get there, and then, when they meet some maths they were struggling with it.

Palis's Head of Mathematics and Mumford's Head of Sixth Form agree that any post-16 student should be able to continue studying mathematics for its own sake, for enjoyment, and to improve their mathematics skills. Students also say they wish to continue with mathematics because they have enjoyed it and find it interesting and/or useful. One Mumford student says "I still wanted to keep maths within my study, so it meant it could be something on the side for me to be able to do".

Our data show appreciation for a mathematics course focusing on applications of mathematics. Jones College's two CM teachers comment that, firstly, "I like the focus on, the practical aspects of maths for people who ain't, gonna be mathematicians", and, secondly, "There are some bits the students really relate to…there's that real world sort of maths I think they like". Arnold College's CM teacher says it is "a great idea to implement maths in context". The contrast with the abstractions of GCSE and A-level is frequently highlighted, as here by Mori's CM teacher:

> …if they get to 16 and they still can't find the angles in a pentagon, does it really matter that much? …the functional element of maths is useful. They should leave college, knowing how to, work out how much change they get when they go to the shop and buy something.

Self-exclusion from A-level Maths

A subset of CM students could have taken A-level Mathematics, having achieved the

required access grade. However, their words betray feelings of inadequacy and fear, reflecting its reputation:

> I was like, right, I'm going to do A-level Maths, but then I got to school on the first day, and I was like, I don't want to do it, I was just scared of how like difficult and stuff it would be at A-level, so I dropped it… I was like, I can't do none of it, but I obviously could if I got a 7. (Donaldson student)
> I got a 7, but I didn't think that'd be enough really. I heard some of the teachers saying, you need to be really good at maths… (Mumford student)

Some believe studying Mathematics A-level would be incompatible with enjoying mathematics:

> I'd thought about doing A-level Maths, but I didn't think I'd enjoy it as much because it seemed quite difficult, so I thought that if I did CM it would be, still doing maths but not, like A-level. (Ball student)

Exclusion from A-level Mathematics

Case study data indicate that students need at least GCSE Mathematics grade 6 or 7 to access A-level, and their potential is usually further assessed prior to and/or early in the A-level course. Even some students with high GCSE grades (B/A, now 6/7) may be turned away following an early assessment. Rousseau's Principal describes the dilemma facing every institution in setting A-level access grades, admitting some, excluding others:

> [Head of Mathematics] was absolutely convinced that because A-level Maths is so difficult he wanted to go down the route that lots of schools are going for, to actually raise the bar of entry, to grade A… I was uncomfortable with doing that without offering an alternative…because you exclude all those students that come with a B who want to do it. A-level Maths is a very popular A-level…so I wasn't prepared to sort of lose all those customers, and it is a customers game effectively.

Having a course to offer those "customers" was essential. Palis's Head of Mathematics

also describes how:

> every year we were finding that some students didn't quite meet our criteria… we literally had students who got one mark off, two marks off their A, and we were just saying no, because if I let one, I'll have thirty other parents, wanting me to let their child on.

Donaldson's Headteacher describes CM as "the perfect option" for students wanting to study mathematics but "who perhaps wouldn't quite meet the entry requirements for the A-level".

There is a shared view that it is detrimental for students to "struggle with" (Bismut, Assistant Principal; Dickenstein, Principal; Palis, CM Teacher) or "not cope with" (Rousseau, Principal) A-level Mathematics. Even though grades E and D are still passes at A-level, and roughly a quarter of students across all subjects, and indeed in Mathematics, are awarded these grades,[viii] Lions's Assistant Principal expresses a more widely-shared view about the particular challenge of A-level Mathematics for relatively lower attaining students:

> sometimes you get students that want to take maths at post-16, but they don't necessarily have the academic skills, to do, or to be as successful as they want to be in maths, and maths becomes quite a, struggle for them, I suppose… and for a student it's not very motivational for them to battle through constantly trying to get an E or a D, whereas Core Maths gives them another pathway.

CM is an opportunity for these students, but equally it could be argued that they should be permitted to take that A-level course and pass with a grade D or E.

Choice between options

Data portrays evident tension between an acknowledgement that students can now be offered a different mathematics qualification and "another pathway", and a sense of

hierarchy of CM relative to A-level Mathematics, sometimes implicit, but often explicit. In contrast to the policy guidance for CM, which clearly states that CM is suitable for all students with grade 4+ at GCSE Maths, Lions's Assistant Principal expresses a view, shared by others, that A-level Mathematics is for the more "academic" student and CM for the "slightly less academic". His comment about students' preparedness for post-16 mathematics also seems to betray a sense of ranking and hierarchy:

> the kids who are better prepared for the new GCSE, will therefore find, certainly at A-level, hopefully, are better prepared, but if you look further down, you probably will have more students that can access Core Maths more comfortably as well.

This metaphor of vertical positioning is found extensively in our data. A Rousseau student uses it to describe being unable to access A-level:

> I couldn't take maths as an A-level, 'cause I got a B instead of an A, so Core Maths was the next alternative, down.

Staff and students alike refer to "dropping down" into CM from A-level. Some, like Bismut's CM teacher, correct themselves or attenuate their words:

> A-level is [GCSE grade] 7 and above, but some of the 7s may end up, coming - I hate to say "down" - coming across to Core Maths! 'Cause that's a bit the attitude they have. I was like no, it's different!

Others use the metaphor freely. Palis's Head of Mathematics describes how "…some [students] dropped back down to Core Maths". Mori's Head of Department compares the process of moving from A-level into CM, following an assessment, to that of formerly moving into Use of Mathematics, a qualification which bore a similar mantle to that now worn by CM, and which CM has been brought in to replace, at Mori and others of our case studies:

> we used to set them a four-week test and they used to drop down into Use of Maths which was mainly coursework based, but, still covered some of the content of A-level Maths.

Bismut's Assistant Principal uses the phrase, "drop down into Core Maths", stressing that the expression is "certainly not one I'd use with students". He euphemistically describes as "guided choice" the segregation of students into A-level Mathematics/Core Maths. Yet students candidly state that their GCSE grade excludes them from A-level:

> 'cause I was doing Foundation maths, I got a 5, it was just automatically Core Maths. (Bismut student)
> I picked it 'cause I couldn't get into A-level Maths, perfectly being honest. (Rousseau student)
> it's people like us three that have ended up defaulting on to it, that end up on it. (Lions student)

To "end up on" CM does not convey a positive choice. CM is a "safety net" (Mori, CM teacher; Dickenstein, Principal), a "consolation prize" (Palis, Head of Mathematics), a "default" (Dickenstein, Principal; Mori, Head of Department), a "default negative" (Palis, Head of Mathematics).

Students are aware of the lower status of CM, as these Rousseau students explain:

> S1 …if you tell someone you're doing, Core Maths, or Level 3 Mathematical Studies, it doesn't have that sort of, impact on a personal statement… It's just the sign saying you're not good enough to do actual maths… That's how it's seen, like, Core Maths and actual maths.
> S2: Yeah, it more stands out like you're not good enough to do A-level.

This Mumford student also uses the downward movement metaphor, and goes further in describing CM as "casual":

> I did A-level Maths, but it weren't for me. So I dropped down to the more casual maths.

Mori's Head of Department says:

> one of the issues we face is the fact that these kids are coming to us wanting to do A-level Maths and they may see Core Maths as sort of a second best alternative, which is something that we're probably quite wary of.

Lions's Head of Mathematics acknowledges that, "some of those students probably think that, it's a step down or, there's a kind of, stigma attached to it as, oh, I'm not good enough for A-level Maths". Palis's Head of Mathematics admits, "I'm sure if you ask the average student they would say that's the course for people who didn't get on A-level Maths". Some staff stress the difference between the two courses, CM being, as Lions's Head of Mathematics says, "an alternative path in maths, not a step down, because it's different, it's a lot more numbers-based". He continues:

> …those students who do sort of, study it and get into it, I think they do appreciate that actually, it has got a place and it's not just, oh if you can't do that I'll do this.

The difference in status is underlined when students move, as does happen, from A-level Mathematics to CM, during or at the end of the year, after an internal assessment or an external exam. The criterion for progression from first to second year of A-level is commonly a grade D; students awarded an E generally withdraw from the course, because they are felt to be too much at risk of failing at the final examination. As students from Lions say, "I thought Core Maths was probably a good way to fill the gap", and "I took Core Maths because at the end of the AS-levels I had failed my A-level Maths and I used this as a replacement for it". Moving from A-level to CM results directly from not attaining the standard deemed necessary to remain on the A-level

course. The student above, who says he has "failed" his A-level, in fact achieved grade E in AS Mathematics at the end of year 1.

Students denied access to A-level Mathematics, or who start A-level and then leave, are often viewed, and view themselves, as deficient, or even as failures. Theirs is not necessarily a positive choice to opt into CM. This is summed up by a Lions student:

> Core Maths wasn't advertised. It was, if you want to do Maths, you go and do Maths and if you fail the entry test you go on Core Maths, and that made it seem very negative… It seemed like, you know, putting somebody on the thick table, which is you know a harsh way of looking at it.

Students in this situation may still appreciate the opportunity to continue with mathematics:

> I enjoyed maths a lot, [in] secondary school… When I tried A-level Maths, I was quite disheartened I couldn't do it properly, and when [HoM] told me about Core Maths opportunities, I grabbed that quickly, because I didn't want to stop doing maths. (Dickenstein student)

Restrictions in programme and progression

The following comment, left hanging, hinting at the relative status of CM, highlights the further challenge of fitting CM into the post-16 structure of three two-year courses:

> 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 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… (Lions student)

Core Maths is sometimes treated as a direct substitute for A-level Mathematics, rather than (as was the policy intention) additionally to a study programme of 540 learning hours. One institution included "Mathematics" in three option blocks at enrolment, intending to create either A-level or CM classes once the group was in place and the

needs (or perhaps the potential) of the group could be assessed. In six of our case study institutions, students were enrolled on CM as the third of their three options. Because CM attracts half the number of teaching hours (180) of a two-year course (360), these students are not enrolled with sufficient learning hours to fulfil funding criteria. Another short course is needed to reach the total number of hours required. Bismut's Assistant Principal declared that an "easy" solution is to enrol students onto the Extended Project Qualification (EPQ)[ix] in their second year post-16. This pairing of CM and EPQ is found in six of our case study institutions. Bismut's Assistant Principal speaks about meeting the needs of the student, which may mean doing two rather than three full courses:

> If you've got 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, or whatever the structure of their timetable is so, it does very much go back to, those sort of guidance conversations and, meeting the needs of, what we have.

Our evidence shows, however, that the "weaker-on-entry" students are not alone in taking CM as one of three first-year options. Institutional structures including timetabling constraints, option blocking or class sizes may steer others into CM. One Mori student had the GCSE grade 7 required to access A-level Mathematics, but was allocated to CM instead because of timetabling complications. She knew this was an unequal substitution, and that CM would not have the same exchange value on applying to Higher Education:

> A-level's worth more at Uni. Like this is only one year, so I'll have to pick something up next year.

Students who begin three full courses including A-level Mathematics, and then move or

are moved to CM, find they might have been better taking a different two-year course, rather than the half-sized CM. They will eventually only be awarded the equivalent of two-and-a-half qualifications, potentially affecting their onward progression into HE. They will be restricted to applications to courses or HEIs who accept the UCAS[x] tariff rather than, or as well as, grades. There is no definitive list of universities which accept students on the basis of the UCAS tariff rather than grades, but we estimate that Russell Group universities are unlikely routinely to make offers on the basis of the tariff, and only a third of all universities do so.[xi]

Discussion

This paper focuses on one aspect of curriculum policy enactment, in the introduction of CM into England's wider education system, with special reference to the well-established and well-regarded A-level Mathematics. We have presented data on student access to and participation in Core Maths, for those wishing to continue studying mathematics, relative to the positioning of the course in our case study institutions. From a social justice perspective, we suggest that, whilst some of the policy intentions associated with the introduction of CM have been realised, different institutions' varied positioning of this new course within the curriculum has variable impact on students' opportunities for progression.

First-order effects

Whilst the extent of CM's contribution to increasing post-16 mathematics participation will be the focus of other papers, our data do highlight positive responses, from teachers, managers and students, to the introduction of a post-16 mathematics option other than A-level, qualitatively different in kind, content and approach, in using and applying mathematics in context. CM is a welcome opportunity for many students for

whom there was previously no post-16 mathematics option (Noyes, Drake, et al., 2011), especially where it is taught, as intended, over two years alongside three other full courses, positioned essentially or overtly as an enrichment or extension course. Students continue refreshing and developing their mathematical skills between GCSE and progression to HE, apprenticeship or employment, whilst their main programme supplies the currency of three A-level (or equivalent) grades needed for applying to HE. Where CM is taught over one year, a period remains when students are not using their skills, unless in other courses; but at least those students have had an extra year of maths. The impact of CM on students' subsequent HE successes and experiences cannot yet be assessed, as linked longitudinal data have not become available.

Second-order effects

A number of second-order effects can be identified, especially in relation to policy rhetoric about choice, diversity, and students' needs. Instead of access and participation, the reality of experience for many students is restriction and exclusion (Dilnot, 2016). The absence of choice is illustrated by Jones College's Head of Department:

> Core Maths chooses you; you don't choose Core Maths.

Early consultation documents clarified that Core Maths is designed for any student who has attained GCSE Maths grade 4 or higher, and that students could be taking any Level 3 programme (Department for Education, 2014a). The documents also referred to the CM target group as "the 'middle group' of students" (ibid., para. 1.3). They stated that the majority would be mid-range attainers, achieving, in GCSE Mathematics, grades B or C (now 6, 5 or 4), but around a third would be high attainers, achieving an A or A* (7, 8 and 9). It may appear counterintuitive that a "middle group" should include high-achieving students; this expression could be interpreted as being influenced by the cultural

privileging of A-level Mathematics over other courses. The expression and conceptualisation were dropped in the eventual Technical Guidance document (Department for Education, 2015).

Our case study data reflect the literature: access to A-level Mathematics is exclusive, and restricted to the highest achievers (Rigby, 2017). Some mathematics educationalists (e.g. Stripp, 2017) believe students with a good pass at GCSE (5+) should be eligible to progress onto A-level Mathematics, as with other subjects. An eventual grade D or E is still a pass in a highly prestigious subject. This would also contribute towards increasing numbers studying mathematics post-16. However, our case study data suggest access has, if anything, become even more restricted following changes to GCSE grading and the decoupling of AS from A-level (Ofqual, 2018). Advice to students about post-16 options depends partly on the accountability framework, within which the institution balances its own interests with those of the individual. Students may be offered CM rather than being permitted to attempt A-level, if, for accountability reasons, the institution prefers to avoid risk. Previously, students could at least achieve an AS qualification from examinations at the end of one year, withdrawing from the course if success in year 2 looked uncertain; in the newly linear environment, where A-levels are examined after two years, institutions demand greater certainty that students can successfully complete a two-year course. Withdrawing partway through affects institutional and course/teacher retention figures.

Post-16 qualifications were introduced as a selection mechanism for HE (Hodgson, Spours, & Waring, 2005). The impact of HE on the post-16 phase cannot be overestimated. CM advocates are encouraging HE to signal the value of CM (A. Smith, 2017). However, this creates tension in a system where the standard university offer is three A-level (or equivalent) grades. Where students are denied access to A-level

Mathematics, or where students believe themselves incapable or unworthy of accessing it, they may choose another two-year course rather than CM, thereby not taking any mathematics post-16. This is a genuine threat to the policy imperative to offer a mathematics course to all post-16 students, not to mention denying individual students the opportunity to study mathematics. Our data show that some post-16 centres are offering Statistics or Accounting A-levels, rather than CM, to ensure students have a full two-year mathematical qualification within a three-grade application package.

In some institutions, CM is a third option for some students, paired with the EPQ as a second-year option to fulfil funding conditions. The EPQ is a highly regarded qualification, showing evidence of independent study skills and allowing students to pursue an individual interest, often with enthusiasm. Indeed, some universities now make alternative offers to students who do well in their EPQ, reducing a grade in one of their other three subjects. However, this is the case for students taking EPQ in addition to a three-qualification programme. With its independent study, and the need for self-motivation and self-management, it is arguably unsuitable for students considered (as Bismut's Assistant Principal described) "weaker", for whom three two-year courses, let alone three plus CM, are judged to risk proving too challenging. This move towards apparently more unrestricted access to the EPQ contrasts with tight restrictions on access to A-level Mathematics. The pairing of CM and EPQ (or, rarely, a different one-year option) to construct a two-year combination to fulfil funding criteria could be considered a marriage of convenience. Students taking what Bismut's Assistant Principal calls a "guided choice" of three subjects, one of which is CM, at the start of their post-16 career, might be better "guided" towards other alternatives in the same or a different institution.

Our data reveal some students who are *not* generally weaker also being allocated to CM as a third option in their first post-16 year, unsure what their second-year programme

will be. For them, a different two-year course might have been better. They cannot apply to HEIs which require three grades for entry; they can only access HEIs or courses using UCAS tariffs. Not knowing enough about how to keep their options open, students without the right educational and cultural capital (Bourdieu, 1984) may be disadvantaged.

Segregating students for different treatment, particularly where differentiated routes may lead to different (and financially more or less favourable) life prospects, should not happen unless justifiable grounds exist that there are defensible differences in students themselves (Pring, 2018). How a course is positioned, and who is invited to enrol, influence whether it is seen as an enriching addition to the curriculum, or a poor substitute. This will be true of any course in any nation with an assessment-led education system, where accountability structures, institutional practices and performativity (Ball, 2003) deny students equal access to courses and qualifications, and thus to opportunities.

Teachers and leaders in our case studies believe CM and A-level Mathematics provide alternative pathways. They certainly do: those post-16 pathways will inevitably lead to different opportunities beyond school or college and into HE/employment. The prevailing rhetoric of choice allows the perpetuation of practices which are acceptable on the surface but whose most negative consequences affect the most disadvantaged students (Pring, 2018; Reay, 2012).

Our data show that students perceive CM to be of less value and status than A-level Mathematics, and teachers generally recognise their students' astuteness. Palis's Head of Mathematics commented that he wanted to take steps "to make it more attractive, and not be seen as a consolation prize". A definite sense of hierarchy exists in centres where A-level Maths, and indeed other two-year courses, are regarded as more desirable than CM. This is in danger of echoing the wider academic/vocational debate, positioning A-level Maths/CM in an academic/vocational dichotomy.

Inequality still pervades the English system, where vocational is seen as lower status (Pring, 2018). Rather than CM being positioned as a useful and valuable qualification for any post-16 student not doing A-level Maths, it may transpire (more research is needed here) that students who go on to attend less prestigious universities are those taking CM. Core Maths has the potential to contribute enormously to post-16 mathematics participation, but, without greater currency, risks sinking into a prescribed, lower status, place in a strongly established hierarchy.

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References

Abrahams, J. (2018). Option blocks that block options: exploring inequalities in GCSE and A Level options in England. *British Journal of Sociology of Education*, *39*(8), 1143–1159. https://doi.org/10.1080/01425692.2018.1483821

Adkins, M., & Noyes, A. (2016). Reassessing the economic value of advanced level mathematics. *British Educational Research Journal*, *42*(1), 93–116. https://doi.org/10.1002/berj.3219

ATKearney. (2016). *Tough choices: The real reasons A-level students are steering clear of science and maths*. Retrieved from https://1cwcpp2qp6hi1exr69469mgu-wpengine.netdna-ssl.com/wp-content/uploads/2016/06/YL-ATK-Tough-Choices-Research-Report-FINAL-3-02-16.pdf

Ball, S. J. (2003). The teacher's soul and the terrors of performativity. *Journal of Education Policy*, *18*(2), 215–228. https://doi.org/10.1080/0268093022000043065

Bell, J., & Donnelly, J. (2006). A Vocationalized School Science Curriculum? *International Journal of Science Education*, *28*(12), 1389–1410. https://doi.org/10.1080/09500690600708600

Bourdieu, P. (1984). *Distinction: A Social Critique of the Judgement of Taste*. Harvard University Press

Bowe, R., Ball, S., & Gold, A. (1992). *Reforming Education and Changing Schools: Case Studies in Policy Sociology*. London ; New York: Routledge

Bowles, S., & Gintis, H. (1976). *Schooling in Capitalist America: Educational Reform and the Contradictions of Economic Life*. Routledge & Kegan Paul

British Academy. (2016). *Professor Sir Adrian Smith's review of post-16 mathematics provision in England: A response from the British Academy*. Retrieved from https://www.britac.ac.uk/sites/default/files/British%20Academy%20submission%20to%20Adrian%20Smith%20review%20of%20Mathematics%20Post-16_FINAL.pdf

Brown, M., Brown, P., & Bibby, T. (2008). 'I would rather die': reasons given by 16-year-olds for not continuing their study of mathematics. *Research in Mathematics Education*, *10*(1), 3–18

Cornish, C. (2017). Case study: level 1 Skills to Succeed (S2S) students and the gatekeeping function of GCSEs (General Certificate of Secondary Education) at an FE college. *Research in Post-Compulsory Education*, *22*(1), 7–21. https://doi.org/10.1080/13596748.2016.1272076

Department for Education. (2013). *Introduction of 16 to 18 core maths qualifications: Policy statement*. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attach

ment_data/file/266717/Policy_statement_on_16-18_Core_Maths_qualifications_-_final__3_.pdf

Department for Education. (2014a). *Core maths technical guidance: Consultation document*. Retrieved from http://dera.ioe.ac.uk/19991/1/Core_maths_technical_guidance_-Consultation_Document.pdf

Department for Education. (2014b). *Launch of new high-quality post-16 maths qualifications*. Retrieved from https://www.gov.uk/government/news/launch-of-new-high-quality-post-16-maths-qualifications

Department for Education. (2015). *Core maths qualifications: technical guidance* (No. DFE-00481-2014). Retrieved from DFE website: https://www.gov.uk/government/publications/core-maths-qualifications-technical-guidance

Department of Education and Science and the Welsh Office. (1988). *The Higginson Report: Advancing A Levels*. London: Her Majesty's Stationery Office

Dilnot, C. (2016). How does the choice of A-level subjects vary with students' socio-economic status in English state schools? *British Educational Research Journal*, *42*(6), 1081–1106. https://doi.org/10.1002/berj.3250

Dilnot, C. (2018). The relationship between A-level subject choice and league table score of university attended: the 'facilitating', the 'less suitable', and the counter-intuitive. *Oxford Review of Education*, *44*(1), 118–137. https://doi.org/10.1080/03054985.2018.1409976

Dolton, P. J., & Vignoles, A. (2002). The Return on Post–Compulsory School Mathematics Study. *Economica*, *69*(273), 113–142. https://doi.org/10.1111/1468-0335.00273

Education and Skills Funding Agency. (2017). *Funding guidance for young people 2017 to 2018. Funding regulations*. Retrieved from www.gov.uk/government/publications

Gillborn, D. (2003). 'Raising standards' or rationing education? Racism and social justice in policy and practice. *Support for Learning*, *16*(3), 105–111. https://doi.org/10.1111/1467-9604.00200

Gorard, S. (2014). The link between Academies in England, pupil outcomes and local patterns of socio-economic segregation between schools. *Research Papers in Education.*, *29*, 268–284

Hodgen, J., Pepper, D., Sturman, L., & Ruddock, G. (2010). *Is the UK an outlier? An international comparison of upper secondary mathematics education*. London: Nuffield Foundation

Hodgson, A., & Spours, K. (2004). Reforming 14–19 Learning. *New Economy*, *11*(4), 217–223. https://doi.org/10.1111/j.1468-0041.2004.00369

Hodgson, A., Spours, K., & Waring, M. (2005). Higher education, Curriculum 2000 and the future reform of 14–19 qualifications in England. *Oxford Review of Education*, *31*(4), 479–495. https://doi.org/10.1080/03054980500355369

Homer, M., Mathieson, R., Banner, I., & Tasara, I. (2017). The early take-up of Core Maths: Emerging findings. *Proceedings of the British Society for Research into Learning Mathematics*, *37(2)*. University of Oxford: BSRLM

Homer, M., Mathieson, R., Tasara, I., & Banner, I. (2018). Increasing post-16 mathematics participation in England: the early implementation and impact of Core Maths *Research Proceedings of the 9th British Congress on Mathematics Education (3-6 April 2018, University of Warwick, UK).* Retrieved from http://www.bsrlm.org.uk/wp-content/uploads/2018/11/BCME9-Research-Proceedings.pdf#page=89

Jerrim, J., Greany, T., & Perera, N. (2018). *Educational disadvantage: How does England compare?* London: Education Policy Institute

Joint Council for Qualifications. (2018). *GCE A-Level & GCE AS-Level Results Summer 2018*. Retrieved from https://www.jcq.org.uk/examination-results/a-levels/2018/main-results-tables

Kounine, L., Mark, J., & Truss, E. (2008). *The Value of mathematics*. London: Reform.

Lingard, B., & Sellar, S. (2013). Globalization, edu-business and network governance: the policy sociology of Stephen J. Ball and rethinking education policy analysis. *London Review of Education*, *11*(3), 265–280. https://doi.org/10.1080/14748460.2013.840986

MEI. (2016). *Response to Professor Sir Adrian Smith's Post-16 Mathematics Review*. Retrieved from http://mei.org.uk/files/pdf/MEI-response-to-Prof-Sir-Adrian-Smith-Post-16-Maths-Review.pdf

Morgan, N. (2014). *Speech at the launch of Your Life campaign*. Retrieved from https://www.gov.uk/government/speeches/nicky-morgan-speaks-at-launch-of-your-life-campaign

Moulton, V., Sullivan, A., Henderson, M., & Anders, J. (2018). Does what you study at age 14–16 matter for educational transitions post-16? *Oxford Review of Education*, *44*(1), 94–117. https://doi.org/10.1080/03054985.2018.1409975

Noyes, A. (2013). The effective mathematics department: adding value and increasing participation? *School Effectiveness and School Improvement*, *24*(1), 1–17. https://doi.org/10.1080/09243453.2012.689145

Noyes, A., & Adkins, M. (2016). Reconsidering the rise in A-level mathematics participation. *Teaching Mathematics and Its Applications*,

(doi:10.1093/teamat/hrv016). Retrieved from http://teamat.oxfordjournals.org/content/early/2016/01/07/teamat.hrv016.full

Noyes, A., & Adkins, M. (2017). *Rethinking the value of advanced mathematics participation*. Retrieved from University of Nottingham website: http://www.nottingham.ac.uk/education/documents/research/revamp-final-report-3.1.17.pdf

Noyes, A., Drake, P., Wake, G., & Murphy, R. (2011). *Evaluating mathematics pathways: Final report* (No. DFE-RR143). London: Department for Education

Noyes, A., Wake, G., & Drake, P. (2011). Widening and increasing post-16 mathematics participation: Pathways, pedagogies and politics. *International Journal of Science and Mathematics Education*, *9*(2), 483–501. https://doi.org/10.1007/s10763-011-9281-4

Nye, P., & Thompson, D. (2018, August 16). Mathematics A-level: Results day analysis. Retrieved 7 December 2018, from Results day analysis website: https://results.ffteducationdatalab.org.uk/a-level/mathematics.php?v=20180904

Ofqual. (2018). *AS and A level decoupling: Implications for the maintenance of AS standards*. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/722590/7_-_AS_Decoupling_Report_-_PROOFED.pdf

Phillips, G., & Pound, T. (2003). *The Baccalaureate: A Model for Curriculum Reform*. Routledge

Pring, R. (2018). Philosophical debates on curriculum, inequalities and social justice. *Oxford Review of Education*, *44*(1), 6–18. https://doi.org/10.1080/03054985.2018.1409963

Reay, D. (2012). What would a socially just education system look like?: saving the minnows from the pike. *Journal of Education Policy*, *27*(5), 587–599. https://doi.org/10.1080/02680939.2012.710015

Rigby, C. (2017). Exploring students' perceptions and experiences of the transition between GCSE and AS Level mathematics. *Research Papers in Education*, *32*(4), 501–517. https://doi.org/10.1080/02671522.2017.1318806

Sealey, P., & Noyes, A. (2010). On the relevance of the mathematics curriculum to young people. *The Curriculum Journal*, *21*(3), 239–253. https://doi.org/10.1080/09585176.2010.504573

Smith, A. (2004). *Making mathematics count*. London: The Stationery Office

Smith, A. (2017). *Report of Professor Sir Adrian Smith's review of post-16 mathematics*. Retrieved from https://www.gov.uk/government/publications/smith-review-of-post-16-maths-report-and-government-response

Smith, E., & Gorard, S. (2011). Is there a shortage of scientists? A re-analysis of supply for the UK. *British Journal of Educational Studies.*, *59*(2), 159–177

Stripp, C. (2017). Charlie's Angles: Reflections on the uptake of AS/A-level Maths, AS/A-level Further Maths and Core Maths. Retrieved 28 November 2017, from Charlie's Angles website: https://www.ncetm.org.uk/resources/50919

Taylor, B. (2014). Importance of Maths A level for studying engineering at university. Retrieved 1 December 2017, from Capital International. Engineering your future website: http://www.capital-staff.com/blog/?p=95

The Royal Society. (2008). *Science and mathematics education 14-19. A 'state of the nation' report on the participation and attainment of 14–19 year olds in science and mathematics in the UK, 1996–2007*. London: The Royal Society.

[i] Advanced-level, pre-university qualification taken in England and Wales, typically at the age of 18.

[ii] For more details about the policy context, see Homer, Mathieson, Banner, & Tasara, 2017; Homer, Mathieson, Tasara, & Banner, 2018.

[iii] General Certificate of Secondary Education, taken by all students at the end of compulsory schooling at the age of 16. Mathematics is a compulsory subject up to this point.

[iv] Use of Mathematics ran from 2009 to 2018 and shared many of the aims of Core Maths.

[v] Advanced Subsidiary level.

[vi] In 2019, OCR/MEI renamed their specifications Core Maths A and Core Maths B.

[vii] Business and Technology Education Council. Career-based qualifications in vocational subjects.

[viii] Source: https://results.ffteducationdatalab.org.uk/a-level/all-subjects.php?v=20190822.2

[ix] Qualification worth 50% of an A-level (CM is worth 40%), which is attractive to universities as it shows evidence of independent study, research and presentation skills.

[x] Universities and Colleges Admissions Service, the centralised service used by students to apply to Higher Education Institutions.

[xi] Personal communication with UCAS office, July 2018.