Differentiated papers and quality of enacted curriculum: Student experiences of preparation for GCSE examinations at age 16

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The 2014 English national curriculum for mathematics suggests that students from 14 to 16 should be taught one of two freshly-aspirational curricula, at 'Foundation' or 'Higher' tier. Related student learning is assessed by two overlapping sets of papers. I draw on two longitudinal studies that included classroom observations and teacher and student interviews involving >500 GCSE students and >60 GCSE teachers, together with teacher and student surveys, in a representative sample of about 40 schools. Data suggest enactment of the curriculum as intended is unusual. Instead, and for a variety of reasons, teachers at both tiers commonly adopt approaches that include teaching a range of content superficially. For students with average prior attainment, this includes coaching for routine questions at Higher tier rather than supporting a broad and deep experience of the Foundation curriculum. I consider apparent and reported implications.

Keywords: assessment; differentiation; coherent curriculum; problem solving; reasoning.

Introduction: the policy context

The new English National Curriculum in Mathematics rolled out from late 2014, for students aged 5-16, where 'curriculum' denotes the range of school-led experiences suggested in Department for Education (2012). It features a more aspirational range of content, an expectation of a robust and flexible fluency with that content, and a renewed focus on mathematical problem solving and reasoning. Such aspirations are widely-espoused, yet attempts at such curriculum reform internationally, including in England, have previously had limited success (e.g. Eurydice, 2011). Teachers in England often have little experience of teaching or assessing for those latter processes across the range of students. Further, English secondary teachers are less highly specialised than in many jurisdictions, with over 20% of secondary mathematics lessons taught by those without a mathematics-related post-school qualification (National Audit Office, 2016).

The Key Stage 4 (ages 13/14-16) curriculum offers two routes, with the Foundation tier 'programme of study' a subset of the Higher tier one. It is recognized that not all students will master all Foundation tier content, but they are expected to be exposed to it all (Department for Education, 2012). Students are usually organized in 'sets' determined by prior attainment. Assessment at age 16 ('GCSE') is by two overlapping sets of papers, targeting GCSE grades 1-5 or 4-9 (with an 'allowed' grade 3) respectively, and it is expected that almost all students in a cohort will take GCSE examinations. GCSE provision is via three main centrally regulated providers, in a market-driven situation. Mathematics outcomes, and particularly grades 4 and 5, are high-stakes for both schools and individuals, since they contribute to key accountability measures for schools and are frequently gatekeepers to further education courses, as well as to jobs.

Research questions and theoretical framework

I draw on two longitudinal studies (2016-2018) around the early enactment of this curriculum, the first focusing on curriculum resources and the second on GCSE assessment materials, in both cases as provided by the market leader, which also funded the research. The second study also encompassed the impact of the resulting GCSE enactment on the effectiveness of student progression post year 11. Curriculum enactment in the classroom is known to be influenced by a range of aspects of the system, including teachers' use of mathematics resources (Remillard 2005), their knowledge, skills and affect, and specific assessments developed (Golding, 2017a,b). Further, students in the same class perceive the enacted curriculum differentially (e.g. Pampaka &Williams, 2016). Mullis & Martin (2015) therefore distinguish between *intended*, *enacted* and *experienced* curricula. A range of evidence suggests that a necessary condition for valid enactment of an intended curriculum at scale, is that all such aspects should be well-aligned, and Schmidt & Prawat (2006) designate this a *coherent curriculum system;* within this, Davis and Krajcik (2005) evidence the importance, especially to less experienced and knowledgeable teachers, of curriculum materials that are *teacher educative* if teacher capacity is to align with curriculum intentions. This paper addresses impact of the tiering structure, together with the high-stakes nature of particular outcomes, on the enacted curriculum choices of teachers, and so the curriculum experienced by students.

The English mathematics curriculum structure differs from that in jurisdictions which mandate distinct curricula for different tracks, early choice of curriculum, or differentiation by time to master a common curriculum. However, re-evaluation of curriculum and assessment regimes, including in relation to the perceived twenty-first century key processes of problem-solving and reasoning, is widespread globally, with assessments near the end of schooling also commonly high-stakes (e.g. Eurydice, 2011), so the broad context of these studies is of wide interest.

The Studies

The studies both spanned the first two years of the new GCSE, and the elements reported involved six field researchers led by the author. Sampling was by a range of school characteristics known to influence teaching and learning: catchment area type and socio-economic profile, school governance, historic school-level attainment at GCSE, and proportion of students with English as an additional language or with special educational needs (Ofsted, 2012), though since the studies were opt-in, more confident teachers are probably over-represented. Data collection was as in Table 1, with all interviews transcribed; all data were analysed first by research questions and then by open grounded sub-themes (Charmaz, 2006). Analysis was validated across researchers and by some teacher participants. Here I focus on two emergent sub-themes: tier entry decisions and related scope of enacted curriculum.

Key findings

Analysis suggests that the study A focus curriculum materials are indeed teacher-educative and both those and the first set of live GCSE papers were well-aligned with intended curriculum. Nevertheless, enactment consistent with those envisaged in Department for Education (2012) appeared relatively unusual, being achieved in only

Table 1: Data collection over Studies A and B.

	Study A: Use and impact of mathematics curriculum resources in KS: Ages 14-16, May 2016 – September 2018 17 Heads of Mathematics, 24 classes each followed over two years to GCSE (sample representative over key features re school and class within that)		**Study B: Use and impact of GCSE assessment-related materials *including re progression* Ages 15-17 February 2017-December 2018** Range of 74 year 11 classes and their teachers over 2 years, 28 schools and Heads of Mathematics (sample representative over key features re school and class within that)
Autumn 2016	Baseline assessment (458 students); 24 Heads of Mathematics/year 10 class teacher telephone interviews		
Spring 2017	20 year 10 lesson observations + class teacher interviews + focus groups (n~80 students)		19 Head of Mathematics, 38 year 11 class teacher interviews, 38 year 11 focus groups (n~140 students)
Summer 2017	20 year 10 class surveys (n=408); 24 Head of Mathematics/class teacher telephone interviews		
Autumn 2017	25 Head of Mathematics/year 11 class teacher telephone interviews		19 Head of Mathematics reflective telephone interviews *Post-16 progression work*
Spring 2018	17 year 11 lesson observations + teacher interviews + focus groups (n~65 students). 16 year 11 class surveys (n=341)		19 Head of Mathematics interviews, 38 year 11 class teacher interviews, 38 year 11 focus groups (n~140 students)
Summer 2018	15 year 11 class teacher surveys GCSE results for 16 classes (n=368 students)		
Autumn 2018	11 Head of Mathematics reflective telephone interviews		19 Head of Mathematics reflective telephone interviews *Post-16 progression work*

8 of 24 classes in study A, and 19 of 74 classes in study B – in all cases, where students were expected to achieve highly on either Foundation or Higher tier. In such cases, teachers were able to draw on a range of related knowledge of curriculum, of pedagogy, of curriculum resources, and of their students, although pedagogy for problem-solving and for reasoning was often described, and observed, to be 'developing'. Some teachers (of at least 7 classes in study A, teaching across both tiers of entry) said they were intending to cover 'the whole curriculum', but either said they thought problem-solving and reasoning as suggested in the resources were inaccessible to their students, and so not a key teaching focus, or when observed, appeared not to possess the knowledge or skills to support the development of those: "This class just don't do reasoning" (Study A school 9, teacher of weak Higher students). At least 9 classes (4 from study A and 5 from study B) had teachers who said they would only tackle problem-solving once their students had 'met' all the target content, and indeed, by March in each year, about a third of student focus groups in study B appeared to have had little experience of the problem-solving that would be assessed in GCSE three months later.

Over half of classes in both studies, then, worked with a subset of the intended curriculum scope only: "We teach as much content as we think students can take" (Study B school 15, Head of Mathematics). Sometimes this was in depth, and, drawing on a range of teacher knowledge, observations and focus groups suggested students experienced related problem solving and reasoning at an appropriate level. In these cases, their curriculum experience appeared coherent, and students could talk about the mathematics they had learned with confidence and a sense of its purpose. They were adept at identifying which questions drew on content they had worked with, and typically said they could attempt most such questions. There remained a significant number of classes in both tiers, though, whose teachers appeared either unwilling or unable to support exposure to a coherent subset of content and the range of functioning within that. Of particular concern are those students entering for either tier who had encountered a subset of content focused on knowledge of facts and procedures only, excluding the intended range of processes. Such students in focus groups typically talked about 'spotting marks' and came to interviews with a clear (though often erroneous) view of how many marks they would need for particular grades. They tended to be low in confidence about their ability to access the mathematics they were exposed to, as well as unconvinced of its role for their espoused future pathways.

In particular, both observations in study A and teacher and student interviews in study B exposed a telling contrast for students of middle prior attainment who might be expected to target grades 4 or 5, which are available from either tier of entry. When preparing for a thorough coverage of Foundation tier material (between half and a third of such students across the studies in 2018), such students could talk knowledgeably and confidently about their mathematical functioning:

> It's just like life.. you're given what you've got and then you have to use that to get an answer…I do feel ..quite proud of myself when I managed to do something that was very challenging for me' (Study B school 14, Year 11 student).

They typically appeared motivated and engaged, and their teachers positive about the developments supported by the new curriculum and related resources:

> That group has massively improved in all of their confidence, their enjoyment, engagement, and their progression (Study B school 7, teacher of year 10 target grade 4/5 students).

Remaining comparable students were preparing for an expected weak performance on Higher tier papers, and here both teachers and students talked in terms of strategic approach to papers, 'mark spotting' (across all awarding organisations in Summer 2018, about 20% of marks were needed to gain the critical grade 4), and 'cherry-picking' acquaintance with Higher tier topics rather than embracing the range of curriculum-mandated mathematical opportunities, despite extensive support available in assessment support materials for developing problem solving and reasoning:

> It's what we need to do, focus on basic questions with just a few topics at Higher tier, given how important those grades are. It's easier for them to get their target grades this way, and they'll get more confident if we do enough papers, but it's not what I'd choose (Study A school 3, teacher of grade 4/5 target students).

Such approaches were more apparent in year 2 of study B, as teachers became more confident to make choices in the new assessment structure. Teachers also referred to the 'safety-net' of an 'allowed' grade 3 by this route, which made it low-risk for weak students barely accessing a grade 4. Other teachers clearly had difficulty with the opportunity for such an approach:

> To get grade 4, 17% (on Higher tier) is shocking…I think it devalues the grade for the kids that worked very hard at Foundation to get there. (Study B school 13, Head of Mathematics).

Similar, but less pronounced, patterns were observed with weak Foundation candidates - though without a choice of tier entry -, with those who had experienced a thorough coverage of processes talking about mathematics much more confidently.

Discussion

This paper focuses on teachers' choice of enacted curriculum - but points to that being a particular issue where students are targeting a high-stakes (for students and schools) middle grade that is accessible via either tier of entry, under the English assessment structure. For students whose teachers choose to address a proper subset of the intended curriculum at either tier, but to address that in depth and through the range of intended mathematical processes, that appears to be a constructive strategy that leads to students confident to function mathematically at an appropriate level. However, the data reported here suggest that for weaker students entered for Higher tier (as well as some weaker students at Foundation tier), a significant proportion of teachers are choosing to focus on a wide range of straightforward elements of content, rather than embracing the curriculum intentions of a broad mathematical experience that includes key (comparatively demanding) mathematical processes. It also evidences some negative impacts of such an approach on students – and on teachers. Teachers' related talk points to perceptions of middle grades being more accessible via Higher tier than via Foundation tier, and to considerations of outcome grades being privileged above considerations of quality of curriculum experience and learning. This is in a context where curriculum materials and assessments appear to be aligned with curriculum intentions, but teacher capacity to fully support the intended curriculum might not be sufficient: the studies do further evidence, consistent with Golding (2017b), that aspirational curriculum change as intended draws deeply on teachers' knowledge of mathematics, of their students, and of the available resources.

These studies should, though, be understood as indicative rather than necessarily generalisable: although representative in many ways, the samples drew only on schools using the most popular curriculum resources and assessments, and remain small-scale; further, teachers opted in. However, data suggest that significant numbers of students are not at present enjoying access to the full range of intended mathematics – with negative implications for their mathematics self-efficacy and their perceptions of the utility of mathematics for their future pathways.

How, then, can coherent depth of enacted curriculum be better supported? Work could be done re-ensuring, and then communicating, comparability of demand of different routes to the same grade, although inevitably students will emerge from those with differential aspects to their functioning. It appears that the role of the ‘allowed’ grade 3 is also problematic, and the whole is framed within a high-stakes assessment culture that is unlikely to change. For some classes, superficial experiences of the curriculum appear to stem from limited teacher capacity, including low confidence that the range of mathematical processes is accessible to all – and yet the studies also offer counterexamples to such doubts. The global evidence suggests challenges to teacher knowledge and skills can only be met by systemic approaches, though further signposting and development of teacher support, including digital, that focuses on approaches to problem solving and reasoning might begin to address such issues. In the long term, national aspirations in England are for large-scale mathematics participation to 18, in which case the role of GCSE could realistically change, but meanwhile, there is clearly work to be done to ensure that student experiences to 16 are uniformly mathematically fulfilling and appropriate.

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