

# **Analysing the Impact of Specification Changes on GCSE Mathematics: A Multi-Layered Curriculum Framework Approach**

## **Abstract**

Curriculum reform constitutes one of the most consequential policy levers available to governments seeking to reshape educational outcomes. This paper examines the cascading impact of governmental changes to the General Certificate of Secondary Education (GCSE) Mathematics specification in England, drawing upon Remillard and Heck's (2014) multi-layered curriculum framework as the primary analytical lens. By situating this framework against earlier conceptualisations proposed by Goodlad et al. (1979) and Schmidt et al. (1996), the analysis traces how policy-level modifications traverse multiple layers of the curriculum system—from official aims and objectives, through consequential assessments and designated curricula, to the operational realities of teacher planning, classroom enactment, and student outcomes. The paper identifies several critical areas of potential impact, including the reinforcement of assessment-driven pedagogies, regional disparities arising from differential policy interpretation by examination boards, disruptions to the textbook market, uneven demands on teacher professional development, and the exacerbation of pre-existing inequalities between well-resourced and under-resourced schools. Through this analysis, the paper contributes to the broader discourse on curriculum policy implementation by demonstrating how a single policy change at the macro level can generate complex, uneven, and often unintended consequences across the education system.

## 1. Introduction

The relationship between curriculum policy and classroom practice has long been a subject of scholarly inquiry in education research (Cuban, 1993; McLaughlin, 1990). In England, the General Certificate of Secondary Education (GCSE) serves as the principal qualification for students at the end of Key Stage 4, and its specifications exert a profound influence on what is taught in secondary schools, how it is taught, and how student achievement is measured (Ofqual, 2013). When the government introduces changes to the national curriculum targets, the effects are not confined to a single policy document; rather, they cascade through multiple layers of the education system, affecting examination boards, textbook publishers, teachers, and ultimately students.

In their seminal paper, Remillard and Heck (2014) outlined a comprehensive multi-layered framework for the analysis of curriculum, building upon and extending earlier conceptualisations by Goodlad et al. (1979) and Schmidt et al. (1996). Two of the most widely referenced frameworks in curriculum studies are Goodlad, Klein and Tye's five-level model—which distinguishes among the ideal, formal, instructional, operational, and experiential dimensions of curriculum—and Schmidt et al.'s tripartite model of intended, implemented, and attained curriculum. While both frameworks have contributed substantially to curriculum analysis, Remillard and Heck (2014) argued that a more nuanced and granular approach was necessary to capture the complexity of curriculum as it moves from policy intention to lived classroom experience.

Building upon the framework that Remillard and Heck proposed, this paper focuses specifically on the analysis of the impact of the government changing the specification of the GCSE Mathematics curriculum. By applying a multi-layered analytical lens, the paper seeks to trace how a single policy-level change—the revision of national curriculum targets by the Department for Education—propagates through the official and operational layers of the curriculum system. In doing so, the paper addresses the following research questions:

1. How does a change in the GCSE Mathematics specification traverse the multiple layers of the curriculum system as conceptualised by Remillard and Heck (2014)?
2. What are the potential consequences of such a change for examination boards,

textbook publishers, teachers, and students?

3. To what extent might the change exacerbate existing inequalities within the education system?

The paper is organised as follows. Section 2 provides a detailed theoretical overview of the curriculum frameworks underpinning the analysis. Section 3 outlines the methodological approach adopted for the conceptual analysis. Section 4 presents the core analysis of potential impact, structured around the key themes of assessment, policy interpretation, textbook markets, teacher adaptation, and educational equity. Section 5 discusses the broader implications. Section 6 concludes with a summary and directions for future research.

## 2. Theoretical Framework

### 2.1 Earlier Conceptualisations of Curriculum Layers

The study of curriculum has been shaped by a number of foundational frameworks that seek to capture the multiple dimensions through which curriculum is conceptualised, enacted, and experienced. Among the most influential of these are the models proposed by Goodlad et al. (1979) and Schmidt et al. (1996).

#### 2.1.1 *Goodlad, Klein and Tye's Five-Level Curriculum*

Goodlad et al. (1979) proposed a five-level conceptualisation of curriculum, distinguishing among the following dimensions:

- (i) **Ideal curriculum:** the curriculum as envisioned by scholars, policymakers, and educational theorists, reflecting aspirational goals for education.
- (ii) **Formal curriculum:** the officially sanctioned curriculum as documented in policy guidelines, syllabi, and approved textbooks.
- (iii) **Instructional curriculum:** the curriculum as planned by teachers in their lesson preparation, reflecting their interpretation of the formal curriculum.

- (iv) **Operational curriculum:** the curriculum as actually delivered in the classroom, which may diverge from the instructional plan due to real-time pedagogical decisions.
- (v) **Experiential curriculum:** the curriculum as experienced and understood by students, which is inherently subjective and varies across learners.

This framework was pioneering in its recognition that curriculum is not a monolithic entity but rather a multi-faceted construct that undergoes transformation at each level. However, Remillard and Heck (2014) noted that the model does not sufficiently articulate the mechanisms through which the curriculum is transformed between levels, nor does it adequately distinguish between the policy-facing and practice-facing dimensions of curriculum.

### *2.1.2 Schmidt et al.'s Three-Level Curriculum*

Schmidt et al. (1996) proposed a more parsimonious model in the context of the Third International Mathematics and Science Study (TIMSS), identifying three levels:

- (i) **Intended curriculum:** the curriculum as specified in national or regional policy documents, reflecting what students are expected to learn.
- (ii) **Implemented curriculum:** the curriculum as interpreted and delivered by teachers in their classrooms.
- (iii) **Attained curriculum:** the curriculum as evidenced by student learning outcomes and achievement.

While this model has been widely adopted, particularly in large-scale international comparative studies, its relative simplicity can obscure the complex intermediary processes through which policy intentions are mediated before reaching students (Remillard and Heck, 2014).

## 2.2 Remillard and Heck's Multi-Layered Curriculum Framework

Recognising the limitations of earlier models, Remillard and Heck (2014) developed a more comprehensive framework that divides the perspectives of curriculum into two main categories: **official** and **operational**. Each category is further decomposed into three sub-levels, and three mediating mechanisms are introduced to explain the transitions between levels.

### 2.2.1 *The Official Curriculum*

The official curriculum encompasses the policy-facing dimensions of curriculum and is divided into three sub-levels:

- (i) **Aims and objectives:** the broad educational goals established by governmental or regulatory bodies. In the context of this paper, these correspond to the national curriculum targets set by the Department for Education of the British Government.
- (ii) **Consequential assessments:** the high-stakes examinations and standardised tests that are designed to measure student attainment against the curriculum. In this case, these correspond to the GCSE Mathematics examination papers regulated by the Office of Qualifications and Examinations Regulation (Ofqual) and written by various examination boards, such as Edexcel and AQA (Ofqual, 2013).
- (iii) **Designated curriculum:** the specific curricular materials—including specifications, syllabi, and textbook series—that serve as the primary resources for instruction. Here, this refers to each examination board's modified GCSE Mathematics specification and the corresponding textbook series.

### 2.2.2 *The Operational Curriculum*

The operational curriculum encompasses the practice-facing dimensions and is similarly divided into three sub-levels:

- (i) **Teacher-intended curriculum:** the curriculum as planned and interpreted by teachers, reflecting their professional judgement and understanding of the designated curriculum.

- (ii) **Enacted curriculum:** the curriculum as actually delivered in the classroom, shaped by real-time pedagogical decisions, student responses, and contextual factors.
- (iii) **Student outcomes:** the learning that students actually achieve, which may or may not align with the intended goals of the policy.

### 2.2.3 Mediating Mechanisms

For each transition between levels, Remillard and Heck identified three distinct mediating mechanisms:

- (i) **Translation:** the process by which curriculum content is rendered from one form to another while attempting to preserve its essential meaning. For example, the GCSE Mathematics specification is *translated* from the national targets set by the government, and the content of consequential assessments is *translated* from the modified specification.
- (ii) **Transformation:** the process by which curriculum content is fundamentally re-shaped as it moves between levels. For instance, textbook authors *transform* the changes in the GCSE Mathematics specification into potential new chapters, example questions, and pedagogical sequences (Pepin and Haggarty, 2001).
- (iii) **Interaction:** the process by which curriculum is co-constructed through dynamic exchanges between participants at a given level. This is most evident in the classroom, where teachers make real-time modifications to their lesson plans in response to student questions and engagement concerning the new specification.

Figure 1 provides a visual representation of the framework as applied to the context of GCSE Mathematics specification changes.

## 3. Methodology

This paper adopts a **conceptual analysis** approach (Jabareen, 2009), employing Remillard and Heck's (2014) multi-layered curriculum framework as the primary analytical tool for examining

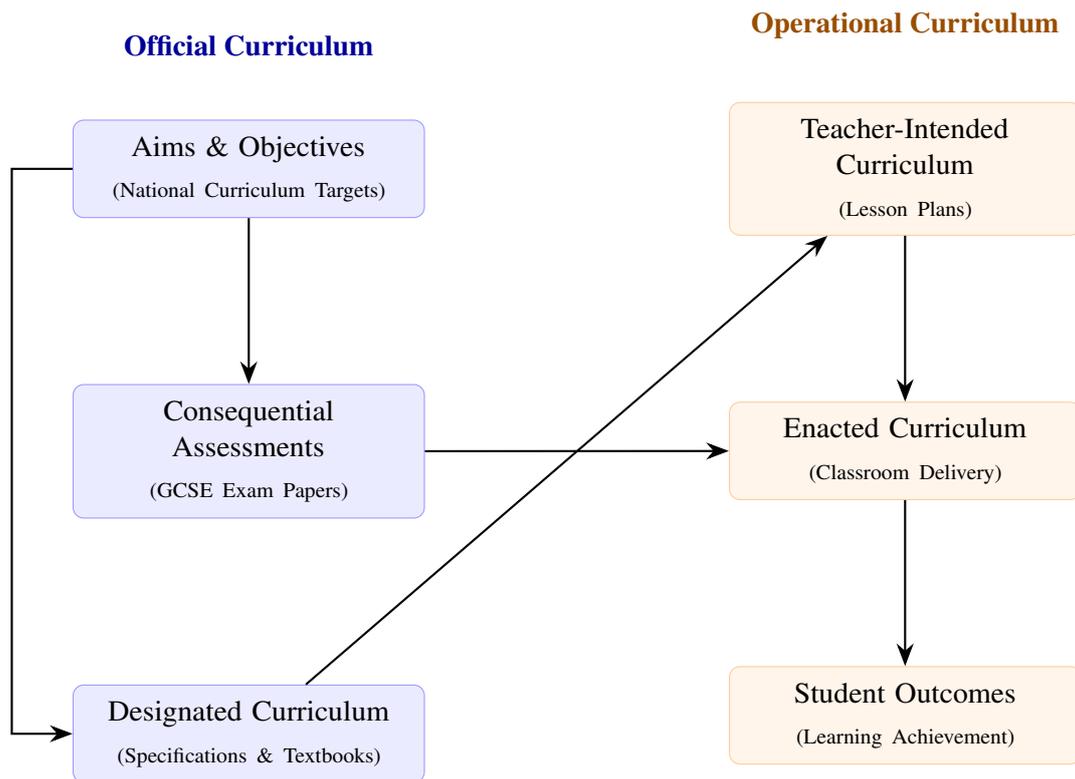


Figure 1: Remillard and Heck’s (2014) multi-layered curriculum framework applied to GCSE Mathematics specification changes.

the potential impact of changes to the GCSE Mathematics specification. Conceptual analysis is an established methodology in education research that involves the systematic examination of concepts, their relationships, and their implications within a defined theoretical context (Nuopponen, 2010).

The analytical procedure consists of three stages:

**Stage 1: Framework Application.** The six sub-levels of Remillard and Heck’s framework (three official and three operational) are mapped onto the specific context of GCSE Mathematics specification changes, identifying the relevant actors, documents, and processes at each level.

**Stage 2: Impact Identification.** Drawing upon existing empirical and theoretical literature, the potential impacts of specification changes are identified at each level of the framework, with particular attention to the mediating mechanisms of translation, transformation, and interaction.

**Stage 3: Critical Synthesis.** The identified impacts are synthesised and evaluated in

terms of their implications for educational equity, teaching quality, and student outcomes, with reference to the broader policy context in England.

It is important to acknowledge the limitations of this approach. As a conceptual rather than empirical study, the paper does not present primary data; rather, it draws upon existing literature to construct a theoretically informed analysis. The findings are therefore indicative rather than conclusive and are intended to generate hypotheses for future empirical investigation.

## **4. Analysis of Potential Impact**

This section presents a structured analysis of the potential impact of changes to the GCSE Mathematics specification, organised around five key themes that emerge from the application of Remillard and Heck's (2014) framework.

### **4.1 The Dominance of Assessment-Driven Pedagogy**

It is widely recognised that curriculum is, in practice, largely shaped by the content and structure of consequential assessments. Cuban (1993) referred to this phenomenon as the *tested curriculum*, arguing that the high-stakes nature of standardised examinations creates a powerful backwash effect on teaching and learning. In the context of GCSE Mathematics, the influence of the tested curriculum is particularly pronounced: the goal of the majority of students—and, by extension, their teachers and schools—is to achieve a satisfactory grade in the GCSE examination.

When changes are introduced to the GCSE Mathematics specification, both teachers and students are immediately drawn to compare the new syllabus with the old. This comparative exercise is not merely academic; it serves a fundamentally pragmatic purpose. By identifying precisely what modifications the examination board has made, teachers can adjust their instructional focus accordingly, and students can target their revision efforts. However, this pragmatic response carries significant pedagogical risks. The heightened attention to specification changes can reinforce an instrumentalist approach to mathematics education, in which the primary objective is to master examinable content rather than to develop deep mathematical understanding (Harlen, 2007).

Au (2007) conducted a qualitative meta-synthesis of 49 studies examining the effects of high-stakes testing on curriculum and found a consistent pattern of curricular narrowing: teachers tended to focus instruction on tested content at the expense of broader educational goals. In the context of GCSE Mathematics specification changes, this narrowing effect may be amplified, as teachers concentrate disproportionately on newly introduced topics—perceiving them as likely to feature prominently in upcoming examinations—while potentially neglecting topics that, though still part of the specification, have not changed and are therefore perceived as less likely to be examined.

Furthermore, the assessment-driven response to specification changes may undermine efforts to promote mathematical reasoning and problem-solving skills. Skemp (1976) distinguished between *instrumental understanding* (knowing rules and procedures) and *relational understanding* (knowing why those rules work and how they connect). An overemphasis on the tested curriculum tends to privilege instrumental understanding at the expense of relational understanding, thereby limiting students' mathematical development.

#### **4.2 Regional Disparities through Differential Policy Interpretation**

McLaughlin (1990) observed that the same policy structure may be interpreted differently by different local authorities, a phenomenon she termed the “implementation problem.” This observation has particular relevance to the process by which GCSE Mathematics specification changes are enacted across different examination boards.

The process of specification change begins with the Department for Education issuing a new set of national curriculum targets. These targets are necessarily expressed at a high level of generality, leaving considerable scope for interpretation. Each examination board—Edexcel, AQA, OCR, and others—must then *translate* these targets into a detailed specification that can serve as the basis for assessment and instruction. While Ofqual provides regulatory oversight to ensure a degree of consistency (Ofqual, 2013), the translation process inevitably introduces variation.

This variation manifests in several ways. Different examination boards may emphasise different mathematical topics, adopt different approaches to the sequencing of content, and

construct assessment items that privilege different types of mathematical competence. Newton (2007) demonstrated that examination boards in England, despite operating under the same regulatory framework, produced assessments that varied significantly in terms of difficulty, cognitive demand, and content coverage. These differences, while individually minor, can accumulate to produce meaningfully different learning experiences for students preparing for different examination boards.

The implications for educational equity are considerable. Students in schools that follow the Edexcel specification may encounter a somewhat different version of the GCSE Mathematics curriculum than students in schools following the AQA specification. When specification changes are introduced, these differences may be amplified, as each examination board interprets and implements the changes in its own way. The result is a system in which the ostensibly national curriculum is, in practice, fragmented into multiple parallel versions, each with its own emphasis and priorities (Baird, 2000).

### **4.3 Disruption to the Textbook Market**

Changes to the GCSE Mathematics specification have significant implications for the textbook market, which serves as a critical intermediary between the official and operational layers of the curriculum (Pepin and Haggarty, 2001; Valverde et al., 2002). Textbooks function as the primary vehicle through which the designated curriculum is made accessible to teachers and students, and they play a central role in shaping both the content and pedagogy of mathematics instruction.

When specification changes are introduced, textbook publishers must respond by producing new or revised editions that align with the updated requirements. This process of *transformation*—in Remillard and Heck’s terms—involves not merely updating content but reconceptualising the pedagogical approach, restructuring chapter sequences, developing new worked examples, and creating new practice exercises. The speed and quality of this transformation process vary across publishers, creating a period of uncertainty and instability in the textbook market.

Valverde et al. (2002) argued that many schools, faced with the inadequacy of any

single textbook for structuring day-to-day mathematics instruction, attempt to purchase multiple versions of textbooks written by different authors. This practice, while pedagogically rational, imposes considerable financial and logistical burdens on schools. The costs of purchasing new textbook sets are non-trivial, particularly for schools operating under tight budgetary constraints, and the process of evaluating, selecting, and distributing textbooks consumes substantial time and administrative resources.

The role of digital resources in mitigating these challenges merits particular attention. Drijvers et al. (2013) argued that digital tools and resources can enhance the efficiency and reduce the costs associated with curriculum change. By purchasing online licences from examination boards and textbook publishers, teachers can gain immediate access to updated materials without waiting for physical textbooks to be printed and distributed. Digital platforms also offer the advantage of being updatable in real time, allowing publishers to issue corrections and refinements as specification interpretations are clarified. However, the effective use of digital resources presupposes adequate technological infrastructure and digital literacy among teachers, conditions that are not uniformly met across the school system (Livingstone, 2012).

Table 1 summarises the key dimensions of textbook market disruption following specification changes.

Table 1: Dimensions of textbook market disruption following GCSE Mathematics specification changes.

<b>Dimension</b>	<b>Challenge</b>	<b>Potential Mitigation</b>
<b>Content alignment</b>	Textbooks must be revised to match new specification topics and emphases	Early publisher engagement with examination boards during specification development
<b>Financial cost</b>	Schools must purchase new editions, often multiple versions	Adoption of digital licensing models to reduce per-unit costs
<b>Time lag</b>	Physical textbooks require months of production and distribution	Digital resources enable immediate access and iterative updates
<b>Pedagogical quality</b>	Rushed revisions may compromise pedagogical coherence	Publisher investment in collaborative authorship with practising teachers
<b>Evaluation burden</b>	Schools must assess multiple textbook options	Development of centralised, independent textbook review mechanisms

#### 4.4 Demands on Teacher Professional Development

The operational curriculum is fundamentally mediated by teachers, whose professional knowledge, skills, and dispositions determine how the designated curriculum is transformed into enacted classroom practice (Shulman, 1986). When specification changes are introduced, teachers are required to adapt their lesson plans, update their subject knowledge, and potentially adopt new pedagogical approaches—a process that demands both time and professional support.

Weiss et al. (2003) demonstrated that the quality of mathematics instruction is strongly associated with the level of professional development that teachers have received. Schools with robust programmes of teacher training and continuing professional development are better positioned to respond to specification changes, as their teachers possess the adaptive capacity to interpret new requirements and translate them into effective instruction. Conversely, schools with limited investment in teacher development may experience a decline in teaching quality during periods of curriculum transition, as teachers struggle to adapt without adequate support.

The demands on teacher professional development are particularly acute in the domain of mathematics, where specification changes may introduce entirely new topics or mathematical approaches that fall outside teachers' existing expertise. Ball et al. (2008) argued that effective mathematics teaching requires a specialised form of knowledge—*mathematical knowledge for teaching*—that encompasses not only mathematical content knowledge but also an understanding of how mathematical ideas can be represented, explained, and connected for learners. When specification changes introduce unfamiliar content, teachers may lack the mathematical knowledge for teaching required to deliver that content effectively, leading to superficial or procedural instruction.

Furthermore, the uneven distribution of professional development opportunities across the school system raises concerns about equity. Teachers in well-resourced schools, particularly those in affluent areas or belonging to large multi-academy trusts, are more likely to have access to high-quality professional development (Cordingley et al., 2015). Teachers in under-resourced schools, by contrast, may receive minimal support, creating a widening gap in instructional quality that ultimately translates into differential student outcomes.

## 4.5 Exacerbation of Educational Inequality

The cumulative effect of the impacts identified in the preceding subsections is the potential exacerbation of pre-existing educational inequalities. The English education system is characterised by significant disparities in resources, staffing, and outcomes between schools serving different socioeconomic communities (Lupton, 2005). Specification changes, rather than being neutral policy interventions, interact with these existing disparities in ways that may amplify rather than reduce inequality.

Schools with abundant educational resources—including access to multiple textbook editions, robust digital infrastructure, experienced and well-supported teaching staff, and strong relationships with examination boards—are best positioned to respond effectively to specification changes. These schools can quickly acquire and evaluate new materials, provide teachers with the professional development necessary to adapt their practice, and ensure that students receive instruction that is aligned with the revised specification.

Schools with fewer resources, by contrast, face compounding disadvantages. They may be unable to afford new textbooks promptly, may lack the digital infrastructure to exploit online resources, may have less experienced teachers who receive less professional development, and may be less able to navigate the complexities of specification interpretation. The result is a slower and less effective adaptation process, during which students in these schools receive instruction that is less well aligned with the new specification and, consequently, less well aligned with the revised assessments.

Critically, the English system lacks a robust mechanism for ensuring that the national curriculum targets set by the Department for Education are consistently translated into equivalent learning outcomes across all schools. While Ofqual regulates the examinations themselves, there is no comparable oversight of the instructional processes through which schools prepare students for those examinations (Ofsted, 2019). In the absence of such oversight, it is estimated that only schools with abundant educational resources can fully achieve the learning outcomes expected by the government, while under-resourced schools fall further behind.

This dynamic is consistent with the broader literature on policy implementation and educational inequality. Anyon (1997) argued that educational reforms frequently benefit already-

advantaged schools while failing to address the structural disadvantages faced by schools in deprived communities. Darling-Hammond (2010) similarly observed that the uneven distribution of teaching quality is one of the most significant drivers of educational inequality, and that policy changes that increase demands on teachers without providing commensurate support tend to widen rather than narrow achievement gaps.

## **5. Discussion**

The analysis presented in this paper demonstrates the value of applying Remillard and Heck's (2014) multi-layered curriculum framework to the examination of curriculum policy change. By tracing the trajectory of a specification change through both the official and operational layers of the curriculum system, the analysis reveals a number of important insights.

### **5.1 The Complexity of Curriculum Mediation**

First, the analysis underscores the complexity of the processes through which curriculum policy is mediated. A change that originates as a relatively concise set of revised national curriculum targets undergoes multiple processes of translation, transformation, and interaction as it passes through the layers of the curriculum system. At each stage, the original policy intention is refracted through the interpretive lens of different actors—examination boards, textbook authors, teachers, and students—each of whom brings their own perspectives, priorities, and constraints. The result is that the curriculum as experienced by students may differ substantially from the curriculum as intended by policymakers, a finding that is consistent with the broader implementation literature (Spillane et al., 2002).

### **5.2 The Role of Structural Inequalities**

Second, the analysis highlights the role of structural inequalities in mediating the impact of curriculum change. The effects of a specification change are not distributed uniformly across the education system; rather, they are filtered through existing patterns of resource distribution, professional capacity, and institutional support. Schools that are already well-positioned tend to absorb and adapt to changes more effectively, while schools that are already disadvantaged tend

to be further disadvantaged. This finding resonates with Bernstein's (1971) observation that the structure of educational knowledge both reflects and reproduces broader social inequalities.

### **5.3 The Tension between Standardisation and Flexibility**

Third, the analysis reveals a fundamental tension within the English examination system between the goals of standardisation and flexibility. The existence of multiple examination boards introduces a degree of diversity and competition that can, in principle, promote innovation and responsiveness. However, it also creates the conditions for inconsistency in the interpretation and implementation of specification changes, undermining the goal of a genuinely national curriculum. This tension is not easily resolved, as greater standardisation risks stifling innovation, while greater flexibility risks exacerbating inequality (Stobart, 2008).

### **5.4 Implications for Policy and Practice**

The findings of this analysis carry several implications for policy and practice:

- (i) **Enhanced coordination between policy and practice.** The Department for Education should consider mechanisms for ensuring that specification changes are accompanied by commensurate support for schools, including funding for textbook acquisition, professional development, and digital infrastructure.
- (ii) **Greater regulatory oversight of implementation.** Ofqual's regulatory role might be extended beyond the regulation of examinations to encompass the oversight of specification implementation, ensuring greater consistency across examination boards.
- (iii) **Targeted support for under-resourced schools.** Recognising that specification changes disproportionately affect under-resourced schools, policymakers should consider targeted interventions to support these schools during periods of curriculum transition.
- (iv) **Investment in digital infrastructure.** The potential of digital resources to mitigate the disruption associated with specification changes should be actively supported

through investment in school-level digital infrastructure and teacher digital literacy programmes.

- (v) **Sustained professional development.** Teacher professional development should be conceived not as a one-off event but as a sustained programme that builds the adaptive capacity necessary to respond to ongoing curriculum evolution.

## 6. Conclusion

This paper has employed Remillard and Heck's (2014) multi-layered curriculum framework to analyse the potential impact of changes to the GCSE Mathematics specification in England. The analysis has demonstrated that a single policy change at the level of national curriculum targets can generate a complex cascade of consequences as it is translated, transformed, and enacted across the multiple layers of the curriculum system.

Five key areas of potential impact have been identified: the reinforcement of assessment-driven pedagogy, regional disparities arising from differential policy interpretation, disruption to the textbook market, uneven demands on teacher professional development, and the exacerbation of pre-existing educational inequalities. Taken together, these findings suggest that curriculum policy changes, however well-intentioned, cannot be assumed to produce uniform effects across the education system. Rather, their impact is fundamentally shaped by the structural conditions—of resources, capacity, and support—within which they are implemented.

The paper makes a contribution to the curriculum studies literature by demonstrating the analytical utility of Remillard and Heck's framework in a specific national context and by identifying mechanisms through which curriculum policy change may reinforce educational inequality. However, the conceptual nature of the analysis represents a limitation, and future research should seek to test the hypotheses generated in this paper through empirical investigation. Longitudinal studies tracking the implementation of specification changes across schools with different resource profiles would be particularly valuable, as would comparative studies examining how different examination boards interpret and implement the same set of national curriculum targets.

Ultimately, if curriculum reform is to fulfil its potential as a lever for educational improvement, policymakers must attend not only to the content of the curriculum but also to the conditions under which it is implemented. Without adequate support for the actors who mediate the curriculum—examination boards, textbook publishers, teachers, and schools—even the most carefully designed specification changes risk being undermined by the very inequalities they may seek to address.

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