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Pursuing systemic improvement through heterarchical school systems: A case of educational resources

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Abstract

England's schooling landscape is being remodelled and the move from hierarchical to heterarchical modes of governance has implications for systemic change strategies. Balancing local and networked autonomy with centralising policies complexifies choices for schools, creating tensions that this article explores through the context of curriculum resourcing policies. In particular, we consider the contemporary case of mathematics textbook schemes in England's heterarchical school system, comparing them with an earlier resource-driven systemic change programme—the National Numeracy Strategy—which was implemented in a more hierarchical governance system. Drawing on key ideas from implementation science and data from a Wellcome-funded study of primary teacher professional learning in mathematics in England, we exemplify the challenges of implementing centralised improvement policies in a nominally schools-led, self-improving, heterarchical education system. Each of the 19 participating schools had evolved a bespoke curriculum, and these hybridised 'mashups' of different resources were enacted with varying degrees of fidelity by teachers. We discuss the implications of this comparative case for systemic improvement, both in the use of educational resources and for policy implementation more generally.

KEYWORDS

educative curriculum resources, heterarchical governance, mathematics, school improvement, textbooks

Key insights

What is the main issue that the paper addresses?

From a previously hierarchical governance structure, marketised and new public management approaches have created a heterarchical school system in England. The consequences for the implementation of national school improvement policies, such as centralised educational resources, is unclear.

What are the main insights that the paper provides?

Resource-driven systemic change policies for primary mathematics are challenging to implement in a heterarchical school system, with schools adopting bespoke curricula and using educational resources with varied adaptability/fidelity and hybridity. This suggests potential limitations to implementing centralised educational resources (and perhaps other school improvement policies) in schools-led systems.

WHOLESCALE SYSTEMIC CHANGE FOR ENGLAND'S SCHOOLS

Many school systems around the world have been experiencing rapid change and reform efforts in recent decades with governments stepping back from hierarchical control of schools in favour of forms of 'meta-governance' (Jessop, 2011). Adopting marketised and new public management approaches enables control through regulation and other forms of 'steering at a distance' (Hudson, 2007) while purporting to increase choice, improve quality, enhance equity and encourage innovation. In this way, governments aim to retain strategic control while relinquishing operational control to schools (Higham, 2013) within a heterarchical system (Ball, 2009) constituting multiple, distributed centres of responsibility.

England's school system has been undergoing particularly significant changes of this type. Full-time state-funded primary schooling in England begins at 4–5 years and ends at 10–11 years, after which pupils continue in secondary education until age 16; compulsory education and training continue until the age of 18. Primary and secondary schools were traditionally nested in local government municipalities (local authorities or LAs) which oversaw and supported them. For over a decade, however, a process of fragmentation and partial reformation of these local arrangements has been underway (Greany & Kamp, 2022). Academisation, a process which transfers schools out of local government (LA) control, has undergone several policy iterations under successive governments. A combination of old, recent, new and emergent schooling arrangements has produced a multi-dimensional middle tier of educational leadership between central government and schools (Crawford et al., 2022). The old responsibilities of local government have been divided amongst new organisations in a not entirely coherent way (Greany et al., 2023; Greany & Kamp, 2022). The biggest newcomers to this middle tier are multi-academy trusts (MATs), which oversee the running of a group of academised schools and became core to the academisation agenda from 2010. Multi-academy trusts differ in size and geographical reach, and leadership responsibilities and accountability processes can vary considerably (Greany & McGinity, 2021). In addition to these additional vertical system governance structures, new horizontal support structures (e.g. curriculum hubs) have emerged as the means of implementing government curriculum

policy across schools. Maths Hubs are the most well established of these regional arrangements (National Centre for Excellence in the Teaching of Mathematics (NCETM), 2023a), although their authority to enforce comprehensive change is somewhat limited by their narrow remit for professional development (but not school standards, for example).

Systemic coherence in education locales has been compromised by the contorting of England's schooling landscape (Greany et al., 2023). This has implications for professional learning and school curricula, and so necessitates reconsideration of the mechanisms of systemic change. Local authorities no longer have responsibility for the performance, teacher development or curriculum choices of academised schools and, as LAs are scaled back, they have reduced capacity to support the remaining LA-maintained schools. This transition to increasingly marketised and non-hierarchical governance structures is not the only form of international policy convergence shaping England's schooling landscape. Comparative studies such as the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) of the Organisation for Economic Co-operation and Development (OECD) have been influential for education policy; one Secretary of State famously called the OECD's Andreas Schleicher 'the most important man in English education' (Gove, 2011). It was not, therefore, surprising that England's Department for Education invested so heavily in adopting pedagogic (and resourcing) approaches from Shanghai and Singapore that were assumed to be key to these jurisdictions' strong PISA performance.

The changes to England's schooling system have occurred in a context where education is highly politicised and where school and system improvement is sought via a raft of simultaneous curriculum, assessment and other reforms. Educational resources are one such lever of national and local change. Herein lies a challenge in England where there has been policy tension between local and national loci of power and responsibility in education in recent years. On the one hand, the localising emphasis of one secretary of state espoused freedoms for schools because 'headteachers and teachers know best how to run schools, not local bureaucrats or politicians' (Gove, 2010). On the other hand, there has been a national improvement agenda with plans for a new national curriculum as 'a core national entitlement' to 'create coherence in what is taught in schools' from the then schools minister (Gibb, 2010). This concurrent centralisation and decentralisation in educational policy in England (Greany, 2022) has provided unclear messaging to schools on decisions regarding curriculum provision and the use of educational resources.

Our particular interest herein is the use of educational resources to drive school improvement in England's new heterarchical schooling landscape. We focus on primary education and the case of mathematics to argue that the pursuit of systemic improvement through educational resources is currently hampered by the heterarchical structure of the remodelled schooling landscape. We draw on some framing ideas from implementation science as it relates to the scale out of resources and the implementation of whole system reform initiatives. This is complemented by a brief overview of literature on educational resources in mathematics education. Key concepts of classroom implementation (fidelity, adaptation and hybridity) and of implementation strategy (technical–rational, reflective–rational and societal–rational) are used to compare two major system change projects, each lasting for more than a decade and implemented into differently organised education systems: hierarchical and heterarchical. Findings from the Wellcome-funded project Equity and Quality in Local Learning Systems (EQuaLLS; 2021–2023) are used to exemplify the difficulties of pursuing systemic improvement in England's current schooling landscape (Greany et al., 2023). The article concludes with a consideration of how shifting educational landscapes constrain centralising efforts to effect curriculum improvement through educational resourcing. We consider the lessons of the two educational resource policy moves to current initiatives in this area, and to the more general challenges of designing implementation strategies that are appropriate to differing educational structures.

IMPLEMENTATION SCIENCE

Given that our concerns are about the potential for successful implementation of education change programmes in varied educational system structures, we briefly outline a few key ideas from this rapidly growing field. Implementation science (Bauer & Kirchner, 2020) is well established in the medical and health sciences so here we consider some of that growing body of implementation research in education, in particular that within mathematics education (Jankvist et al., 2021). Our interest is focused on the implementation of national policy and change strategy rather than the implementation of research itself (or its impact) but many of the issues and framing ideas can be transferred.

Probably the best recent overview of the implementation science field is Century and Cassata (2016). They highlight five key reasons for studying implementation and offer some useful concepts, one of which is to 'understand whether, and to what extent, the innovation achieves the desired outcomes for the target population' (p.174). They explain that 'effective implementation depends on individuals' and organizations' capacity for, and receptivity to, change and their joint process of adapting an innovation to meet local needs' (p.178). To individual and organisational capacity, we could add systemic capacity, since we are focusing on national change programmes, and the successful implementation of such also requires input from sector-level organisations. Given that any implementation occurs in complex and changing environments, the extent to which fidelity to an innovation can be maintained is clearly of interest and Century and Cassata explore this and the relationship between structural and cultural dimensions of the process.

Century and Cassata discuss an implementation scale which has a pro-fidelity perspective at one end and a pro-adaptation perspective at the other, and we use this in our analysis of educational resource implementation. Some scholars argue for 'productive adaptations' somewhere between these extremes (Debarger et al., 2013). One such middle position is advocated by Krainer (2021) writing from the context of a national initiative: the Austrian Innovations in Mathematics and Science Teaching programme. Krainer distinguishes between technical rationality for (systemic) innovation and a reflective rationality for (local) improvement, proposing a centre position of societal rationality. These are useful concepts for our argument below.

Technical rationality assumes that there are 'general solutions to practical problems' that can be affected 'by means of publications, training, administrative orders' (Krainer, 2021, p.1178). In contrast, reflective rationality assumes that 'complex practical problems require particular solutions', which can only be developed 'inside the context in which the problem arises' and are 'only rarely … successfully applied to other contexts' (Krainer, 2021, p.1178). Yet these rationalities are clearly better aligned with different structural arrangements in the educational system itself. England's schooling landscape has to a large extent been remodelled on a paradigm of reflective rationality and heterarchical governance (cf. Gove's localism above) with greater freedoms for schools to create or adopt local solutions fitted to their context. This contrasts with school systems in which hierarchical governance allows for more technical rational approaches to educational change. Krainer proceeded to highlight the need to find a middle position of societal rationality that sees the simultaneous need for locally relevant solutions and a degree of commonality that can aid systemic change efforts.

The final point we want to make here is that although we are interested in the implementation of a policy around newly designed textbook schemes, this innovation did not happen in isolation but amongst a plethora of contemporaneous changes and the reverberations of previous ones (cf. Ball et al., 2012). These are not only within mathematics education but also in curriculum more generally and in the general structuring of schooling. Ball et al.'s (2012) careful analysis of 'how schools do policy' reminds us of the sheer volume and complexity of this policy soup and opens up the challenging question of how one

understands implementation (of an innovation) alongside interaction (with other innovations, systems and practices). We now turn to consider educational resources and issues of fidelity/adaptation and hybridity in educational resource implementation.

TEXTBOOKS AND OTHER EDUCATIONAL RESOURCES

Textbooks and their connection to curriculum

Our titular use of the term 'educational resources' acknowledges the range of textbooks and other resources used to support teaching and learning towards curricular goals (Rezat et al., 2021). These print and digital curriculum materials are intended to help deliver a curriculum specification and as such are 'tools that are linked directly to curriculum delivery' (CooperGibson Research, 2018, p. 4) and are distinguishable from topic, subject and/or stimulus resources which are used in lessons such as manipulatives, images or literature (Marks et al., 2023). In this sense, educational resources are instruments that determine the content, instruction and perception of mathematics (Rezat et al., 2021).

There is an extensive literature on textbooks and other educational resources in mathematics education and there is not space herein to do this justice (see Fan et al. (2018) for a good recent overview). What we do want to highlight are the features of these debates that are pertinent for the case in question. In comparative studies, such as Haggarty and Pepin (2002), issues of textbook quality in England have been highlighted where repetitive tasks and topics inhibit coherence. Analytical studies have found English textbooks lacking in features of effective instruction for secondary schools (Hodgen et al., 2010) and primary schools (Petersson et al., 2023). Limited iterative design and evaluation is one reason for this lack of quality (Hodgen et al., 2010), but ongoing policy churn is not conducive for careful, sustained resource development programmes (cf. Japan and other countries where precision and sequencing have been honed over time; Alajmi, 2012).

The design intentions of educational resources can be merely for classroom use or for something deeper—for teacher professional learning. In the early stages of the National Numeracy Strategy (NNS), considered in more detail below, the evaluators noted that teachers were unsure of whether the resources were teaching and learning tools or professional development materials (Earl et al., 2000) and this discussion of 'educative curriculum materials' has been well rehearsed in the literature for many years (Ball & Cohen, 1996; Davis et al., 2014; Davis & Krajcik, 2005). Professional development support for textbook use is considerably less for England's generalist primary teachers than their specialist counterparts in Singapore, for example (Petersson et al., 2023). Central to our study is the use of educational resources as mediators of reform ideas that translate from intended to enacted and attained curriculum Rezat et al. (2021). To use educational resources in this way—as educative curriculum materials that enable student learning and strengthen teacher knowledge—policy makers in England need to address the existing issues of resource quality, design and supporting professional development, as well as shift teacher thinking on their use. We explore this next.

Teacher use of textbooks and other educational resources

Research highlights the different ways in which mathematics teachers make use of textbooks (Lepik et al., 2015; Pepin et al., 2013) and this is becoming more complex in countries like England where fidelity to a scheme is not centrally required. Ruthven (2013, p. 1077) explained that 'in their everyday practice teachers draw on a range of resources, often adapting and combining them to create—in contemporary parlance—mashups'. Such

hybrid arrangements of multiple educational resources are quite common in England where teachers match varied resources to their working contexts and educational values, curating their own local resource collections and acting on recommendations from colleagues to determine quality (CooperGibson Research, 2018). Although Siedel and Stylianides' (2018, p. 130) study is of secondary mathematics teachers, they describe how they found 'thirty-six highly individualized packages of resources, with little commonality'. This contributes to considerable variation in the quality of learning experiences with obvious implications for systemic improvement where these educational resources are intended to create national change in mathematics education. The freedom of adaptation and hybridity comes at a cost for teachers in England with their spending significant amounts of time designing, searching for and adapting resources (CooperGibson Research, 2018; Marks et al., 2023). There is also no guarantee that materials selected are educative in the sense that they enhance teacher knowledge of teaching or of mathematics (Siedel & Stylianides, 2018), particularly when adapted or chopped up to create resource hybrids. Wang and Fan (2021) characterised secondary textbook use in England as 'passive', limited to in-class use where 'dipping into' or 'selecting from' is directed by the teacher. This is quite different from use in Shanghai, for example, where they are for personal use by the student, typically for homework as well as in class, where the textbook drives curriculum sequencing and teachers guide students through the sequence. In contexts where there is reasonably good fidelity to a single textbook scheme, the particular choice of text can have an effect on learner outcomes, according to van den Ham and Heinze (2018). Single textbook use is rarely the case in England where hybridity has been commonplace; 64% of primary schools in England use textbooks as supplementary resources for mathematics teaching according to the TIMSS international survey responses (Mullis et al., 2008), and we suspect that this has only increased.

This limited and varied use of educational resources in primary mathematics in England is a serious barrier for a resource-driven approach to school improvement; having the right 'high-quality' textbooks is necessary but insufficient. In the Department for Education's own research, adaptability (as opposed to fidelity of use) is a feature of resources deemed 'high quality' by teachers and school leaders in England (CooperGibson Research, 2018), so reducing adaptation is a key challenge for policies pursuing systemic improvement through educational resources. Next, we consider two epochs of national primary mathematics improvement in England, the NNS and Teaching for Mastery (TfM). Each was implemented in differently structured schooling landscapes (hierarchical and heterarchical) and so provide complementary insights into the implementation issues related to using educational resources to drive school improvement. In this endeavour, educational resource implementation is our focus, rather than the merits, effectiveness or impact of the individual policies.

TWO MATHEMATICS-IMPROVEMENT PROGRAMMES FOR ENGLAND'S PRIMARY SCHOOLS

The National Numeracy Strategy (1998–2010)

In 1997 the Wew Labour government swept to power under Blair's 'Education, Education, Education' slogan. The then Secretary of State for Education (David Blunkett) immediately mobilised a national strategy for primary mathematics education, applying general solutions in the pursuit of systemic change (technical rationality). This saw the scaling 'out' to all schools and 'up' into policy (Moore et al., 2015) of the National Numeracy Project which had been piloted in 12 localities from 1996 to 1998. Blunkett commissioned the Numeracy Matters report (DfEE, 1998), which set out a comprehensive national plan for the NNS. Much of what was proposed was implemented.

At that time (i.e. before the process of academisation described earlier) England's c.16,800 primary schools were nested geographically within 152 LAs, within nine Government Office Regions, each responsible to government. The implementation of the NNS could therefore 'flow' from Government Office Region to LA to school cluster and to every primary school. Government thereby had some operational as well as strategic control over schools through the hierarchical structure of the system, with a relatively straightforward route from national policy to local implementation, with mechanisms consistent across the country. There was huge investment in 'a massive training and capacity-building "cascade" model to support both professional development and strategy implementation involving … 600+ consultants and other local assistors' (Fullan, 2000), supporting the initial and ongoing professional learning for headteachers, school subject leaders and teachers. The NNS framework (DfEE, 1999) comprised yearly teaching programmes for Reception to Year 6, but this was swiftly supplemented by a wide range of additional educational resources, such as unit plans which provided daily objectives, vocabulary and activities for units of mathematics teaching. These educational resources were not statutory but were widely adopted as such by schools (Earl et al., 2003). The fidelity of implementation of the core NNS educational resources in classrooms was supported by central training cascaded via LA teams to schools with national training materials aligned to NNS educational resources (Earl et al., 2000, 2003). While this hierarchical system rollout allowed for high saturation and low hybridity (i.e. supplementation or blending with other schemes), over time the implementation process did see some gradual adaptation and hybridising (Earl et al., 2003); the approach later expanded into the early years of secondary schooling. The NNS was a high-cost policy and the large sums of money allocated were important for implementation (e.g. teacher guides, professional development packs, 'catch-up' programmes and training videos). This funded more than just educational resources, but these were a key feature (Earl et al., 2003; Fullan, 2000), disseminated through the then hierarchical structures of the schooling system.

The initial gains in learner outcomes in the early years of the NNS were plateauing by 2006 (DfE, 2011a; Tymms, 2011) and the Strategy was significantly revised into a combined literacy and numeracy Primary National Strategy framework (DfES, 2006) where outcomes sustained but did not significantly improve until the programme's conclusion (DfE, 2011a). During this time, the NCETM was established in response to the Making Mathematics Count report (Smith, 2004). This national platform was to manage and coordinate professional development for teachers, bringing together regional and national organisations (signalling a shift more towards reflective rationality) and helping to address the shortage of mathematics teachers. The NCETM was later tasked with setting up and running the aforementioned network of regional Maths Hubs in 2014.

Teaching for mastery (2014 to present)

With the new Conservative-led coalition government in 2010 came accelerated transformation of the schooling landscape in England. New Labour's academisation policy was extended to allow all schools to become academy converts (while continuing to require it of schools deemed underperforming). Academies, not under LA control, had direct accountability to central government but essentially had operational control over themselves (as a single academy or, more commonly, as a group of schools in a MAT). This, alongside the dissolution of the national curriculum and assessment body (the Qualifications and Curriculum Authority, QCA) on Prime Minister Cameron's 'bonfire of the quangos', created new spaces for local and national teacher professional development and for educational resourcing. New approaches to school improvement were required to replace the function of LAs and new sources of national guidance materials were needed in place of the QCA. The

schools minister was keen to continue drawing on approaches in PISA's high-performing systems, in particular Shanghai and Singapore, and to steer a new path for mathematics teaching for England. Yet the technical rationality of national strategies was no longer de rigeur in the new national-localism of educational marketisation and school freedom. Against this backdrop, England's TfM emerged.

The implementation of TfM was via a range of policy measures which encouraged participation from schools, consistent with the move to increased school autonomy (i.e. reflective rationality). This policy assemblage included the creation of a pseudo-market for educational resources and teacher professional learning, one in which state-funding maintained some steering from a distance from government. Some educational resources were partially or fully state funded and the notion of what constituted effective educational resources was influenced by the schools' regulator (Ofsted) and the requirements of national tests. This created what Boylan and Adams refer to as a market mirage in TfM with 'apparent choice hiding state direction' over educational resources (Boylan & Adams, 2023, p.1).

Teaching for Mastery was narrower than the NNS and had an explicit focus, at least initially, on teacher pedagogy (over content, subject knowledge and assessment). Without a QCA or network of LAs covering all schools to guide school improvement, the DfE commissioned the NCETM, funding them to establish the Maths Hubs network which would rollout TfM to schools from 2014. Yet the large Hub footprints did not map onto the old map of smaller LAs or new geographies of MATs, and schools were initially free to access any Maths Hub (or none) for optional professional development. This was symptomatic of government's declining operational control over schools in the move to heterarchical governance. While it created spaces for innovation it also produced inequities in support, and fragmented implementation pathways.

Government attention to mathematics teaching in jurisdictions that perform highest on international mathematics tests (DfE, 2011b), led to a focus on the educational resources of Shanghai and Singapore in the pursuit of systemic improvement. The England–Shanghai teacher exchange highlighted the importance of fidelity to a single national textbook to sequence carefully selected content into small steps, providing a coherent approach, using consistent representations and the use of variation theory (Boylan et al., 2019), all tenets of NCETM's TfM approach (National Centre for Excellence in the Teaching of Mathematics (NCETM), 2023b). As noted above, textbooks had not previously been used extensively in primary schools in England. Only 15% of Year 5 classes (9- to 10-year-olds) had a textbook as a basis for instruction in 2007 (Martin et al., 2008), and 10% in 2011 (Mullis et al., 2012). While there are a number of possible reasons for low textbook take-up, the provision of national educational resources and wraparound support from LAs in the NNS era is no doubt a contributory factor (Askew et al., 2010).

Tim Oates' (2014) 'Why textbooks count' report, argued for the importance of textbooks as a mechanism (a) for raising the quality of mathematics education and (b) for improving curriculum coherence via government controls on approval. This emboldened the government's championing of textbooks with the Schools Minister for England later calling for an end to the 'ideological hostility' to textbook use in England's primary schools (Gibb, 2017). Teaching for Mastery textbooks, based on translations of Singapore textbooks, were developed by publishers for England's primary schools with two textbook series trialled in 2014–2016 and one, *Maths No Problem!*, making it to the government's list of approved schemes. A second textbook, *Power Maths*, was added later. From 2016, books on the approved list were eligible for government match-funding for schools on Maths Hub TfM programmes (approximately 6%, rising to 40% of schools from 2017 to 2022; National Centre for Excellence in the Teaching of Mathematics (NCETM), 2019, 2022). In 2020, some schools could apply for 80% funding for initial investment in (but not maintenance of) approved textbooks. These textbooks were designed as complete educative resources, intended to be used alone and

with fidelity, but were frequently supplemented with other materials by teachers in classrooms (Marks et al., 2023) and not all of the schools that purported to closely follow a TfM approach in 2014–2017 used them (Boylan et al., 2019).

While textbooks have been recognised as a core element of a mastery approach and designed as comprehensive programmes, most schools in England did not adopt a full textbook scheme (Blausten et al., 2020). In a schools-led system, schools (or MATs) are free to choose how to structure their mathematics curriculum and use educational resources. The educational resources market has seen a proliferation of free and paid resources which claim to be 'mastery' schemes but are not full textbook programmes. White Rose Maths and Mathematics Mastery are two of the most popular schemes which are borne out of the England's new school system, from educators originally working for a Maths Hub and a large MAT respectively. There are now just over 100 curriculum resources used to teach primary mathematics in England with substantial hybridity; only 3% of schools are using a single resource without supplementation, and 46% of schools are without a main scheme and using resources from a range of sources, according to a survey of 664 schools conducted by Marks et al. (2023). These figures and the range of alternative resources suggest that, despite government endorsement and funding, textbook take-up and use—as holistic educative resources as used in Shanghai and Singapore—continue to be relatively low. To further explore what has happened in England's primary schools, we draw upon previously unreported data from the EQuaLLS project. Using the lenses of fidelity/adaptation and hybridity, we provide examples of how educational resources are used in primary mathematics teaching in three localities in England, reflecting on what this suggests about how educational resources are implemented in a heterarchical school system.

THE EQuaLLS PROJECT

The EQuaLLS project was funded by Wellcome from 2021 to 2023 and aimed to understand evolving local learning landscapes for teacher professional development and learning (Greany et al., 2023). Given the relatively advanced state of the development of the NCETM and Maths Hubs network, and the ongoing importance and attention paid to mathematics, the project centred on primary mathematics as its case study.

The research design comprised case studies of three differing localities in England: (1) part of a large city; (2) a post-industrial town; and (3) part of a Shire LA areas with a mixture of rural communities and more populated centres. In each locality six or seven primary schools were sampled in such a way as to be broadly representative of the range of schools in that area based on school type, pupil numbers, age-range, FSM, EAL, inspection gradings and pupil mathematics attainment. System leaders with responsibility for the locality were interviewed (e.g. Maths Hub directors, local authority mathematics leads, teaching school heads, Ofsted regional directors), as well as the headteacher, mathematics curriculum leader and a class teacher from each school. Interviews, 30–60 min in duration, were audio-recorded, transcribed verbatim and coded in NVivo by two researchers using a three-tier codebook in order to explore the six key features of learning landscapes that comprised the theoretical framework developed for the EQuaLLS project: (1) the local lens; (2) many linked systems; (3) professional learning; (4) practices, tools and routines; (5) bridging boundaries; and (6) sense-making (the project methodology is described in the appendices of Greany et al., 2023). This framework derived from a synthesis of literatures on socio-spatial theory, complex systems and professional learning in education (reported in Greany et al., 2024). Findings were sense-checked with participants in locality workshops. The project's high-level findings (reported in Greany et al., 2023) fit into four broad themes

of incoherence, inequity, inconsistent support for quality and invisibility of locality leadership in teacher professional learning.

For this study, we used two subsections of the EQuaLLS dataset: the 19 school case study summaries and the school interview extracts coded as pertaining to 'shared tools', a tier 1 code which included data on the use of educational resources for mathematics (textbooks, schemes and materials). Schools were grouped according to the number of educational resources they used (one or multiple) with those using multiple resources falling into two categories: one main resource with some supplementation, or a deliberate choice to use multiple resources. This provided three categories of hybridity (columns in Table 1). Analysis of the interview data showed that schools had polarised assumptions over whether it was desirable for teachers to use educational resources with fidelity. For those for whom fidelity was not a priority (rows 2 and 3 in Table 1), there was a difference between those valuing adaptation (typically to tailor to learners' needs) and those that did not really adopt any resource consistently. The latter group simply made resources optionally available for teachers or expected them to create their own materials from a high-level overview of the resource. This bespoke (re)design within an existing resource framework seems to be at the extreme or perhaps beyond the pro-adaptation end of Century and Cassata's (2016) implementation scale. How the EQuaLLS schools are distributed within these groupings is presented in Table 1 with hybridity (left to right) and fidelity/adaptation (top to bottom) used as scales. Each school is represented using a single statement which characterises the overall position of the school on educational resource use (sometimes using phrasing from the school staff), as distilled from their interview data. The two resources supported by the TfM textbook scheme (*Maths No Problem!* and *Power Maths*) appear in five of the 19 schools, in two where they are used with high fidelity and low hybridity. This project has a distinct advantage over 'self-reported' analyses from educational resource suppliers and projects focused on an individual scheme which are vulnerable to confirmation bias. The summary in Table 1 shows how disparately educational resources have been adopted in practice in the 19 schools in the EQuaLLS project.

Across the sample, educational resources were used with varied levels of hybridity, adaptation and fidelity. Nine of the schools explained that they used one educational resource (five White Rose, two Mathematics Mastery, one *Power Maths* textbooks and one *Maths No Problem!* textbooks). Their reported use of these varied from complete fidelity (seven) to as 'a scheme but not a scheme' or a 'loose interpretation' (eight) to merely as a 'starting point' (four). Similarly, schools that substantially supplemented a main educational resource did so at all levels of fidelity from close adherence but with some teachers using an alternative 'under the radar' to 'loose' and partial use (i.e. just the overview and no other resources). Some school staff echoed the sentiment expressed in TIMSS 2007 that they actively resisted close compliance to a scheme (Mullis et al., 2008), instead allowing teachers to design their own resources for their classes. One mathematics lead in an academy explained that their school approach was working well, influenced by a 'traditional' pedagogy and focus on 'rote' learning. They did not see a need for adoption of, or close adherence to, a specific educational resource:

> The school hasn't always jumped on every bandwagon. For example, with something like *Maths No Problem!*, okay, I've seen it, I've got a few questions, I want to see how this plan rolls out over a couple of years. I don't want to sort of buy into the whole system. White Rose is a helpful framework but we will take what's good from it, but also use our own.

Some schools made a deliberate choice to use multiple educational resources or resource 'mashups'. These ranged from a closely adhered to bespoke curriculum using three educational

TABLE 1 Educational resources used to teach mathematics in the Equity and Quality in Local Learning Systems (EQuaLLS) project schools, including a short descriptor and/or quote to characterise each of the 19 schools.

Use	Single educational resource—low hybridity	Main resource with supplements—moderate hybridity	Amalgam of resources—high hybridity
Follow closely—high fidelity	*Maths No Problem!* textbook with fidelity Mathematics Mastery with all plans written by the Mathematics Lead *Power Math*s textbook which they 'stick quite closely to' 'Reliance' on White Rose materials	*Power Maths* textbook but teachers still follow White Rose materials 'under the radar' NCETM professional development materials and times table scheme, which they 'follow closely'	Deliberate mixture of *Power Maths* textbook, White Rose and Mathematics Mastery, followed consistently
Follow loosely but adapt—moderate fidelity	Mathematics Mastery as a 'scheme but not a scheme' White Rose materials used with 'a pinch of salt', with concerns that teachers could become 'over reliant' 'Loose' interpretation of White Rose materials which they 'don't rely heavily on'	White Rose materials but 'not religiously' with other resources not discouraged White Rose 'adapted' by individual teachers and 1 minute maths app 'Loose' interpretation of White Rose mixed-age plans and times table scheme	*Power Maths* textbook with White Rose materials and NCETM professional development materials also 'encouraged' NCETM professional development materials and 'all different bits of schemes' used with adaptation
Draw upon for own design—low fidelity	White Rose materials as a 'starting point'	White Rose materials as 'a starting point', drawing upon Nrich materials also. White Rose materials 'like a spine' (not worksheets) and Number Sense	White Rose materials, NCETM professional development materials, Primary Stars and Classroom Secrets which form a 'Frankenstein curriculum' which is different from class to class

resource schemes/textbooks, to a 'Frankenstein curriculum' of two with some supplementation, to 'all different bits of schemes' in a more ad hoc teacher-led approach. Others (eight schools) embraced the coherence and support of educational resources, although some achieved this through supplementation or multiple resource use. This could have been, in part at least, guided by the regulatory framework for schools in place at the time of data collection which focussed on curriculum mapping and coherence. Hybridity also seemed to be fluid over time. One mathematics lead, from an LA maintained school, explained:

> We were a Mathematics Mastery school for a while. And we've kind of come out of the other side of that. We didn't keep it going, but we did take from that what we liked. We had a big meeting and once we decided that we weren't carrying on, we said Right, we've finished this, what do we want to do with it? What which bits did we like? Which bits did we not like? We've kind of morphed lots of different things together and I've driven that.

This school had high hybridity and high fidelity, with three educational resources forming the school's curriculum which all teachers followed closely. While a government approved textbook was one of the three educational resources, it was used in a limited and specific way as the third of three resources.

In the 19 schools there were 19 different approaches to educational resource use for mathematics teaching. While we are not claiming that these 19 schools are representative, we are confident that another sample of a similar size would merely add to the range of approaches. The bespoke combinations of, and approaches to using, educational resources in primary mathematics teaching were thoughtfully focussed on meeting the needs of children in order to enable them to succeed in national statutory assessments. Intended to support quality mathematics practice, teachers with quite different expertise and experience needed support to navigate the resource mashups in each school with schools and MATs taking a variety of approaches to providing this. In one small school, the headteacher was broadly resistant to 'mathematics schemes', worrying that it would deskill teachers, making them less responsive to what the children are doing. This led to individual teachers finding their own resources which generated workload to identify, access and tailor resources (CooperGibson Research, 2018). For one novice, early career class teacher that we interviewed, the Maths Lead in the school would recommend additional resources to support the teaching of specific topics such as geometry, with this enhanced use suggesting that educational resources are viewed as supportive of professional learning but as a stepping stone to having the pedagogic knowledge to be able to teach without this support.

Workload reduction was a perceived benefit of close fidelity to a textbook on the government's approved list in another school. This was very much the view of the mathematics lead that we interviewed but the class teacher only echoed this to a point. They explained that they had 'had the training' from the textbook provider, which had been beneficial, but this had been when the textbook was introduced. Quite quickly, they and their colleagues began to use some parts of their previous scheme 'under the radar' which they felt were more suitable for teaching some topics. The challenges of overcoming teachers' perceived limitations of any one resource are substantial given the previously low levels of textbook take-up in England and continuing issues over quality and alignment with national assessments (Mullis et al., 2008).

Bespoke curriculum materials require bespoke professional development support and schools may find it challenging to provide the sustained professional development to teachers to build sufficient depth of understanding of the educational resources mashups they use. It is unsurprising that England's teachers receive reduced professional development for using textbooks compared with their counterparts in other countries (e.g. Singapore;

Petersson et al., 2023). The EQuaLLS project schools are examples of the longstanding issues of quality, design and professional development which we discussed above but are exacerbated by rollout through heterarchical structures. In most of the 19 schools the government-approved textbooks had not been implemented. Where they had, this tended to be with greater fidelity but often in combination with other resources, which raises questions about how to evaluate their effectiveness when deployed in such hybrid ways. In a heterarchical system, most of these schools created their own approaches, blending and adapting existing resources together with their own materials to try and meet local needs (reflective rationality), rather than following the national steer towards fidelity to a high-quality textbook. The failure to implement textbooks as intended is, we argue, a product of the remodelled schooling landscape in England. The implication is that future moves to create systemic change through educational resources will suffer similar implementation challenges. In the next section we discuss the implications for current and future policy moves to use educational resources for school improvement in primary mathematics.

DISCUSSION AND IMPLICATIONS

In England, increasingly heterarchical governance structures, and the associated reflective rationality that underpins improvement planning, have resulted in locally curated curricula. Our analysis paints a jumbled picture of primary mathematics teaching where educational resource mashups are characterised by multiplicity and hybridity, each resource being deployed with varying degrees of fidelity and adaptation. These well-intentioned attempts to create optimal context-specific learning experiences, within school and MAT autonomy, result in curriculum heterogeneity. Indeed, there does not appear to be any unified national version of mathematics in England's primary schools. There are probably as many flavours of mastery as there are schools, or at least MATs, many of which are striving for greater consistency in their enacted curriculum. Responsibility for resource curation and adaptation largely resides with curriculum leaders or class teachers rather than educational designers (of textbooks or policies) and system leaders. The value of any one textbook or scheme as an educative curriculum resource that promotes deep, sustainable and systemic teacher learning is thereby undermined. Indeed, we found scant evidence of curriculum materials being used in an educative way whereby teachers engage with the design principles underpinning the resource. Our findings, and those of Marks et al. (2023), show that multiplicity and hybridity characterise education resource use for primary school mathematics in England.

Given previous low levels of textbook use in England, coupled with the consistent encouraging of schools to develop local curricula (i.e. reflective rationality), it is unsurprising that the implementation principle of adaptation is dominant over that of fidelity—both within and between educational resources. This highlights one of the problems of applying policy ideas and resourcing approaches from contexts with hierarchical governance (and implementation pathways) for use in heterarchical schooling systems. In hierarchical contexts, the implementation of standardising policies, with assumptions of technical rationality, can be achieved more easily. The goal of national curricular improvements through educational resources therefore requires different implementation strategies in heterarchical and hierarchical systems. Reusing systemic change approaches from our educational past (or some other jurisdictions) will arguably not work without some structural changes to the English education system; governance structures and implementation strategies need to be sufficiently well aligned. Writing at a time of major political change in England, this point is worth noting.

While there was no comparable EQuaLLS study on the hybridity and fidelity of NNS educational resource use, the climate of technical rationality and organisation of the school

system meant that lower hybridity and higher fidelity were likely. In contrast, the route from government policy to classroom practice in the remodelled heterarchical school landscape is more direct for some schools and much more convoluted for others with multiple mediating factors providing an inequitable landscape and demanding greater reflective rationality. We are not saying that one of these contexts and approaches is better than the other, rather that different schooling structures create different conditions and possibilities for action and systemic change. Each has strengths and weaknesses.

The NNS pursued systemic improvement in hierarchically arranged primary mathematics education through the cascade of educational resources and professional development. Regardless of political leaning and individual viewpoints on the content, focus and funding of the materials, the hierarchical nested structure of the schooling landscape 1999–2011 meant that central government could use ca. 150 LAs as meso-level units in an implementation model designed to reach each primary school using very similar methods with reasonably equitable access for all schools. Such structural arrangements, together with substantial funding, were probably significant factors in the uptake of NNS educational resources in most schools, despite it being non-statutory. Conversely, TfM and the national textbook scheme initiative was implemented in the remodelled heterarchical schooling landscape with a multidimensional middle tier of distributed responsibilities including Maths Hubs. The implementation challenges for each Hub are significant, having a much larger footprint and number of schools than a LA and much narrower remit, and without any operational control over school mathematics. Coupled with school/MAT freedoms over professional development, curriculum and resources, and the sheer variety of these over 1200 non-geographic Trusts (ranging in size from two to over 70 schools) these issues highlight the limitations to implementing change when the government has relinquished operational control in moving to a heterarchical school system.

So where does that leave the pursuit of systemic improvement in England's schools, in primary mathematics teaching, and via educational resources? In a heterarchical system where government has relinquished operational control and instead steers education through curriculum, funding and accountability, the potential for achieving systemic change through things like educational resource policies is diminished. Increasingly complex educational markets, together with greater school freedoms and the new multidimensional 'middle tier', have obfuscated policy messaging over things such as educational resources, thereby reducing traction for the pursuit of systemic change through standardised, technical–rational policies and implementation strategies. The EQuaLLS project evidence (2021–2022) and low textbook take-up/retention rates (Marks et al., 2023) suggest that the national textbook policy did not fulfil its objectives.

All of this raises interesting questions about the potential for achieving systemic curricular improvement through mechanisms such as educational resources without changes in the school system itself. England's current £43 million investment in the Oak National Academy[i] educational resource curriculum is a case in point. Forming an arms-length curriculum quango in the form of the Oak National Academy signals a policy move to reign in the educational resource marketplace in an attempt to recover strategic control of school curricula. Given the current state of England's fragmented education system, implementation is likely to be hampered by a lack of systemic capacity for such a national change. We strongly suspect that this 'pendulum swing' from heterarchical curricular localism towards a stronger notion of re-nationalised curriculum (resourcing) will be difficult to achieve for the reasons discussed herein.

So, while school improvement can be pursued in many ways, this example of educational resources in primary mathematics raises broader questions about how systemic change can be achieved in differently modelled schooling landscapes. One might argue that the trend over recent decades has been a shift from the technical rationality of New

Labour with their 'lift all ships' approach to a much more reflective rationality where local solutions, curricula and resourcing hold sway. Achieving a more balanced societally rational approach to systemic intervention and change would only be possible if the schooling system reorganised itself, or was reorganised (from outside), so as to balance smaller-scale localism (i.e. schools know best what to do) and one-size-fits-all, technical–rational thinking. The Maths Hubs might be a vehicle to achieving this, but as discussed in the EQuaLLS report, they are struggling to cope with locally fragmented schooling landscapes too. It is difficult to engage schools in optional development activities and coordinate between diverse agents and organisations in the complex, shifting multidimensional middle tier of the English education system.

Regardless of their quality, the pursuit of a textbook catholicon as the unitary solution to the disparity and personalisation in primary mathematics educational resources use found in the EQuaLLS project will probably prove fruitless in a fractured, uneven, distributed and incoherent system. In the case of curriculum resourcing discussed herein, the new public management approach to educational markets, with their rhetoric of options, freedoms, autonomy and self-improvement at local level, is jarring with systemic improvement policy moves at national level. The contorting schooling landscape and its heterarchical governance means that future pursuits of systemic curricular improvements through strategies such as educational resources will probably have limited impact. We think it highly likely that the same principles apply in other areas of strategic educational change.

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CONFLICT OF INTEREST STATEMENT

There are no conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

Research data are not shared.

ETHICS STATEMENT

The research was conducted with approval from the School of Education Ethics Committee at the University of Nottingham. All research participants gave informed written consent.

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ENDNOTE

[i] Oak National Academy is an independent public body which was initially established to create online lessons during the Covid-19 pandemic in 2020 but was appointed in 2022 as the government's arms-length body responsible for curriculum.

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