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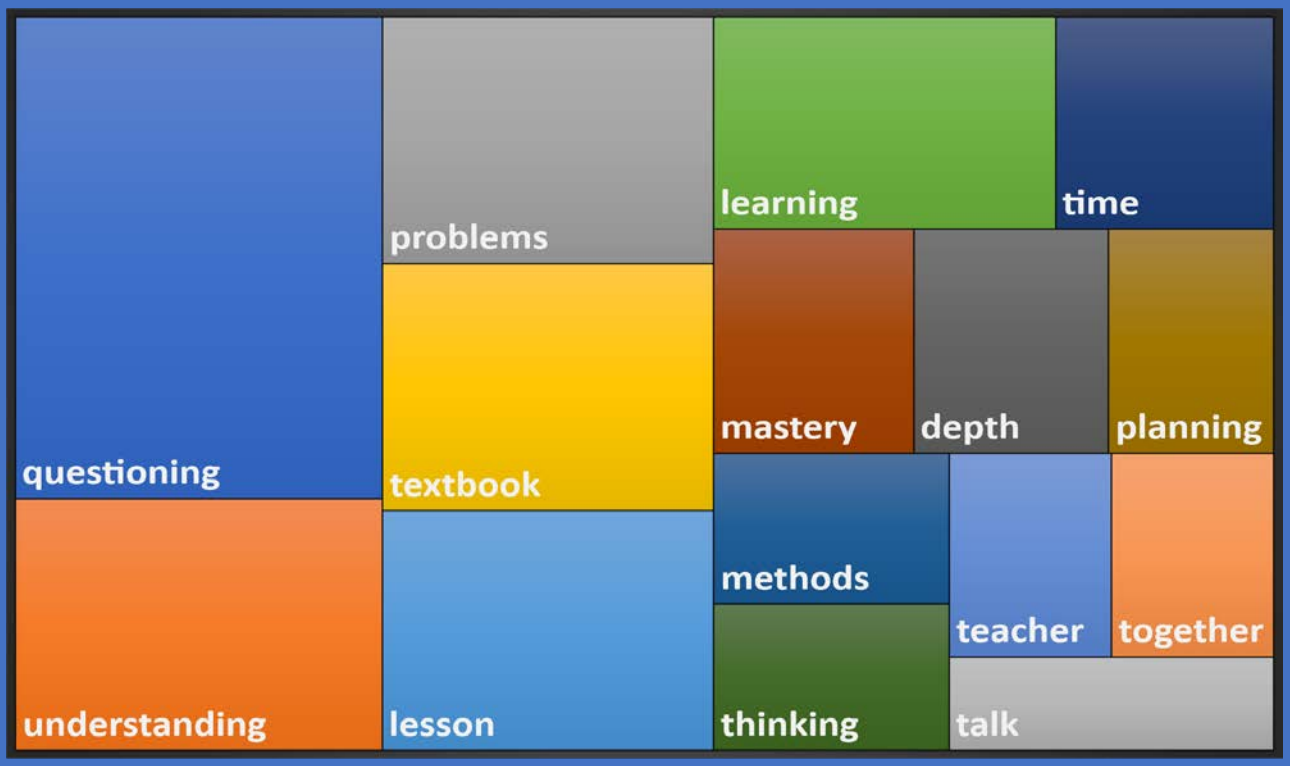
MATHS NO PROBLEM!

Examining Newly Qualified Teachers' use of Textbooks to Support a Mastery Approach to Mathematics Teaching in Primary Schools: A case-study



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Contents

List of Figures

List of Tables

List of Acronyms used in the Report

ACME	The Advisory Committee on Mathematics Education
CPD	Continuing Professional Development
CuREE	Centre for the Use of Research and Evidence in Education
DfE	Department for Education (UK: 2010 – present)
GCSE	General Certificate in Secondary Education (England & Wales: exams at age 16)
ITT / ITE	Initial Teacher Training / Education
KS1	Key Stage 1 (England & Wales, ages 5-7)
KS2	Key Stage 2 (England & Wales, ages 7-11)
MaST	Mathematics Specialist Teacher Programme
MSL	Mathematics Subject Leader
NAMA	National Association of Mathematics Advisers
NCETM	National Centre for Excellence in the Teaching of Mathematics
NQT	Newly Qualified Teacher
NQTs+1	Newly Qualified Teacher plus 1 year of service, i.e. a teacher in their 2nd year
PISA	Programme for International Student Assessment
SATs	Statutory Assessment Tests (England only: conducted at the end of KS1 and KS2)
SEN / SEND	Special Educational Needs / Special Educational Needs and Disabilities
TIMSS	Trends in International Mathematics and Science Study

1 Executive Summary

The new National Curriculum in England (DfE, 2013) – often described as a mastery curriculum – and the ongoing focus on standards has seen theoretical and practical discussions around the implementation of mastery increase of late. One pedagogic tool closely associated with a mastery approach is the use of the mathematics textbook, which has had something of a turbulent past in mathematics teaching in England, particularly in primary schools. Currently two textbook schemes have been assessed by the Department for Education's expert panel as meeting the core criteria for high quality textbooks: Maths No Problem! and Power Maths Key Stage 1. To date, given the relative newness of these tools, evaluations of the introduction of textbooks in England have been limited, focussing on pupil progress and changes in teacher practices and subject knowledge.

1.1 The uniqueness of this report

This report has the particular circumstances of Newly Qualified Teachers (NQTs) who join a school part way through the embedding of major pedagogical change as its focus. NQTs bring to their first post recently developed understanding of mathematical learning theory together with limited experience in the classroom. In joining a school undergoing what Mathematics Subject Leaders (MSLs) will hope to be transformational change (Cordingley, Buckler & Isham, 2012) in mathematics teaching practices, they face a unique situation: how to learn to take responsibility for their pupils' mathematics learning while also learning how to manage the structure, organisation and recommendations of the mathematics textbook/scheme, and how to draw on and make sense of mathematics learning theory in so doing.

While this report touches on changes in teacher practices and subject knowledge as examined in other textbook evaluations, its chief and unique focus is on how textbook use by NQTs has been supported in the case-study schools and how these new teachers are beginning to mediate and take responsibility for their use of textbooks to support pupil learning.

1.2 Research questions

In order to examine the unique issues faced by NQTs and to establish the frameworks supporting them, the research was underpinned by three questions:

i. What is the nature of newly qualified primary teachers' understanding of a mastery approach?
ii. How do Newly Qualified Teachers make use of textbooks to translate theory into practice?
iii. How are Newly Qualified Teachers supported to understand the role of textbooks in the transfer of theory to practice?

1.3 Research approach

To address the questions above, a multi-site case study was conducted in four primary schools in the South-East of England. Each school had already undertaken to embed the major pedagogical change to mastery and used a textbook or scheme to support this as their main learning resource. In addition, each school had a Newly Qualified Teacher who took up their position in September 2018. A qualitative research methodology was used to explore the questions in depth, understanding how Newly Qualified Teachers experienced the issues highlighted above. Further, these findings led to the proposal of a series of recommendations for the stakeholders involved: schools, teacher trainers and textbook publishers.

1.4 Key findings

The key findings associated with each research question are shown in the table below.

What is the nature of newly qualified primary teachers' understanding of a mastery approach?	• NQTs describe a complex and interconnected understanding of mastery conceptualising mastery as both a goal and an approach. • NQTs describe depth of mathematical understanding and flexibility in approach to problem-solving as twin aims in achieving mastery • NQTs understanding of mastery as an approach encompasses a focus on collaboration and talk, the use of representations, conceptual simplification and same-day intervention
How do Newly Qualified Teachers make use of textbooks to translate theory into practice?	• Operating within the structure of the scheme provided, the NQTS in our study demonstrated a strong degree of security that children's learning is progressive over time and within individual lessons • NQTs and MSLs viewed teacher autonomy in mediating the use of the textbook as important; NQTs were confident to make decisions to either work with or deviate from the textbook or lesson content
How are Newly Qualified Teachers supported to understand the role of textbooks in the transfer of theory to practice?	• Support for NQTs is comprehensive and wide ranging, providing the NQTs in this study with confidence that they are operating as part of a consistent and coherent approach to mathematics teaching • NQTs identify clear links with the theoretical underpinnings of the mastery approach in relation to key theorists (e.g. Bruner (1966) and Skemp (1976)). This enables them to translate theory to practice confidently in relation to the use of representations and a focus on depth of understanding • Understanding of variation theory is not well established amongst NQTs and is also a developmental area for staff teams • MSLs in MNP! schools are explicitly aware of and confident in the theoretical underpinnings of their scheme

1.5 Recommendations

In relation to the findings (above), a series of recommendations are made, summarised as:

Recommendations for schools: support Newly Qualified Teachers in making links between theory and practice, helping them to understand and use the principles of textbook design for mastery, ensure key staff attend publisher-led training, with senior school leaders taking an active role in textbook implementation and enabling ongoing opportunities for discussion and support for all staff.

Recommendations for teacher trainers: support trainees in developing a robust understanding of learning theory and an appreciation of mastery components as reflecting good practice, ensuring a solid comprehension of the appropriate selection and utilisation of representations and examples to support children's learning.

Recommendations for publishers: support schools in structuring and providing ongoing within-school Professional Development (including a focus on supporting learners at both ends of the attainment spectrum) in addition to encouraging schools to allow recently qualified teachers to attend publisher-led training as well as receiving 'top-up' training in the more complex elements of mastery.

2 Introduction

Concerns about mathematics teaching and the mathematical literacy standards of children and adults in England are commonplace in the media. England's position internationally can be told in different ways. The most recently available data (PISA, 2016; Mullis, Martin, Foy, & Hooper, 2016) shows the United Kingdom's / England's positions to be unchanged, sitting close to the international averages and comparing favourably with much of the rest of Europe (see Figure 1). However, other countries' positions have not remained static, and it is the gap of 72 points (on a scale from 0-1000) between England and Singapore (the highest performing jurisdiction) at Grade 4 / Year 5 (ages 10-11), which launches calls for improvement.

Figure 1: TIMSS 2015 international mathematics achievement data (Mullis, Martin, Foy, & Hooper, 2016)

Looking beyond international surveys, concerns about mathematical standards – sometimes referred to as a "mathematics crisis" in the UK – are not entirely unfounded. Reporting on data from 2011, National Numeracy (2014) noted that low levels of numeracy are a long-term problem for the UK, and that, worryingly, standards appear to be falling, with only 22% of working age adults in England having skills levels equivalent to GCSE Grade C or above in mathematics. While a far higher proportion of young people leaving school today attain at least a Grade 4 (the current nomenclature

for Grade C) in mathematics, significant concerns have been raised about how prepared today's young people are to use mathematics in employment and in their everyday lives (Hodgen & Marks, 2013), with a potential cost of low numeracy skills to individuals and to society of billions (National Numeracy, 2014). Further, there exists something of a societal apathy towards mathematics (Brown, Brown & Bibby, 2008), and an acceptance that it is okay to say you "can't do maths" (Marks, 2013).

Education sits highly on the agenda of politicians and lay-people as vested parties attempt to find the panacea to school improvement with one – not always stated – aim being to move England up the international comparison tables. The search for this solution is not new. Previously located variously in (but not limited to) prescriptive pedagogies (such as those seen within the National Numeracy Strategy), wider-school systems such as setting (Francis et al., 2017) and specific professional development programmes (Askew et al. 1997), current approaches favour looking towards the highest performing jurisdictions in mathematics and 'borrowing' specific policies and methods to emulate in our teaching in England. It is within this agenda that 'Teaching for Mastery' and its incumbent practices, borrowed from the high-performing education systems of Shanghai and Singapore, has come to play such an increasingly important role in mathematics education in England recently.

While an overarching analysis of whether adopted practices 'work' wholesale is important, a deep, nuanced evaluation of practices – and their constituent components – may allow us to better understand the 'when' and the 'why' of both what seems to work, and what mitigates things working, on the ground. It must be remembered that teachers and teaching differ significantly across jurisdictions. Clapham & Vickers (2018, p.787) argue that when "policy borrowing" we cannot underestimate the fundamental structures underpinning the English education system. One crucial structural difference is that of generalist primary teachers in England. While in the highest performing jurisdictions, teachers are specialists in primary mathematics, possessing what Ma (1999) termed a profound understanding of fundamental mathematics, primary teachers in England are generalists, teaching all subjects and often having limited confidence in doing and teaching mathematics. Very recent concerns have been raised that teachers may transfer their own anxiety about mathematics to the children they teach (Carey et al., 2019) and primary mathematics subject knowledge is an area of increased research focus (Marks, Barclay, Barnes and Treacy, 2019).

Trainee teachers, to various degrees, are exposed to the seminal theorists in, and important evidence on, mathematics education (see, for example the multitude of studies considered in Hodgen, Foster, Marks, & Brown, 2018). These seminal theorists – in particular Skemp (1976) and Bruner (1966) – are the inspiration for many of the approaches currently advocated within 'Teaching for Mastery' (Williams, 2019). The persistent problem is that much of this seminal, well-founded theory is not habitually or reliably translated into practice, particularly once trainees become Newly Qualified Teachers (NQTs). Evidence for this can be seen in the uncritical "haphazard, fragmented" use of teacher developed material readily available online from websites such as Twinkle and Pinterest, where the children's tasks come before, or often in the absence of, underpinning theory (Gustafson, 2019, n.p.).

The problem of how to get theory into the classroom, how to ensure that pedagogic decisions are driven by a sound theoretical basis, is nothing new. 'Teaching for Mastery', much of which is strongly embedded in theory, might provide access to, and spaces for, theoretically informed decisions, but, as with other borrowed policies, risks reducing the role of the teacher to that of a 'technician' (Boyd, & Ash, 2018, p.221), delivering pre-packaged lessons to a compliant class. This research focussed on

one component of 'Teaching for Mastery' – the decision to use a textbook or structured scheme[1] – and how it might support the translation of theory encountered in training, and engagement with further theory, into the thinking and classroom practices of Newly Qualified Teachers.

3 Research Aims and Questions

This research focussed on the use of textbooks as a central feature of 'Teaching for Mastery'. It aimed to explore how NQTs make sense of, and are supported to use, textbook approaches. We examined how textbooks might allow teachers to make theoretically-informed pedagogic decisions, providing a conduit through which theory covered in training can be realised in NQT practices.

We aimed to make recommendations to ITE providers and schools regarding teacher training and CPD and to publishers regarding the role they can play in supporting the successful use of textbooks in school.

This research was underpinned by three questions:

i. What is the nature of newly qualified primary teachers' understanding of a mastery approach?
ii. How do Newly Qualified Teachers make use of textbooks to translate theory into practice?
iii. How are Newly Qualified Teachers supported to understand the role of textbooks in the transfer of theory to practice?

4 Background

Mathematics education research "has a long history" (Inglis & Foster, 2018, p.462) with international publication dating back over 50 years. In this time, a wealth of evidence has been collated, challenged and debated, providing the background – to various extents – to the shape of mathematics education in our primary schools today. As noted in the introduction, some work has proved seminal, underscoring practice for several decades, while other interventions and approaches have been variously trialled and come in and out of fashion over the decades. In this short section we provide a brief overview of the literature in relation to the key themes of this project: mastery approaches to mathematics teaching, the use of textbooks, and school-change and professional development.

4.1 Mastery and primary mathematics

Before looking at 'mastery' itself, it is worth noting that the mastery agenda sits within a rapidly changing climate of mathematics education policy directives; this is a locale which is rarely stable. It is also important to be aware that with these policy changes enactment concerns and difficulties often arise, not least because of the way key terms are used either without definition or with multiple conceptualisations across the academic, policy, and practice literatures (Roper, Threlfall & Monaghan, 2005). Mastery falls into this trap, having no single definition (NAMA, 2015). Indeed Askew et al. (2015) identify four ways in which the term is used: to describe an approach (a set of principles and beliefs underpinning teaching), as a set of pedagogic practices (teaching in a mastery

[1] Henceforth we use 'textbook' to indicate any structured mastery material package including textbooks and online schemes.

orientated way) as a goal (teaching to attain mastery of mathematical topics), and as a curriculum (a set of concepts and ideas). This is particularly challenging for schools as they grapple with how to implement such a "nebulous concept" (Townsend, 2015, p.124).

Mastery itself does not appear as a term in the National Curriculum in England, yet the curriculum is often referred to as a mastery curriculum. This has been pushed strongly by the NCETM and brought to educators' and researchers' attention through the Maths Hubs and Shanghai Mathematics Teacher Exchange project. The concept of mastery is not new, having its roots in Bloom's (e.g. Airasian, Bloom, & Carroll, 1971) mastery model and in particular US mastery programmes. While studies of these approaches have returned positive effects (Hodgen, Foster, Marks, & Brown, 2018), it is important to distinguish Bloom's work from the mastery learning approach currently being promoted in England. While the approach being promoted in England shares some features with Bloom's mastery model – in particular a focus on a uniform degree of learning for all learners and the desire for students to achieve a deep understanding of, and competence in, the mathematical concepts being taught (NCETM, 2016) – the stronger focus in England on structure, early intervention and the coherent and consistent use of representations positions England's approach as somewhat different.

While the core elements of England's approach to mastery (coherence, representation & structure, mathematical thinking, fluency, variation) have been succinctly brought together by NCETM (see Figure 2)[2], and are argued by many to simply represent 'good teaching', it is left to schools and teachers to develop these principles into specific practices. To do so requires significant investment in time in understanding the theoretical underpinnings of these ideas; while aspects of fluency such as number facts may seem fairly innocuous, getting to grips with the complexities of procedural and conceptual variation would take some effort.

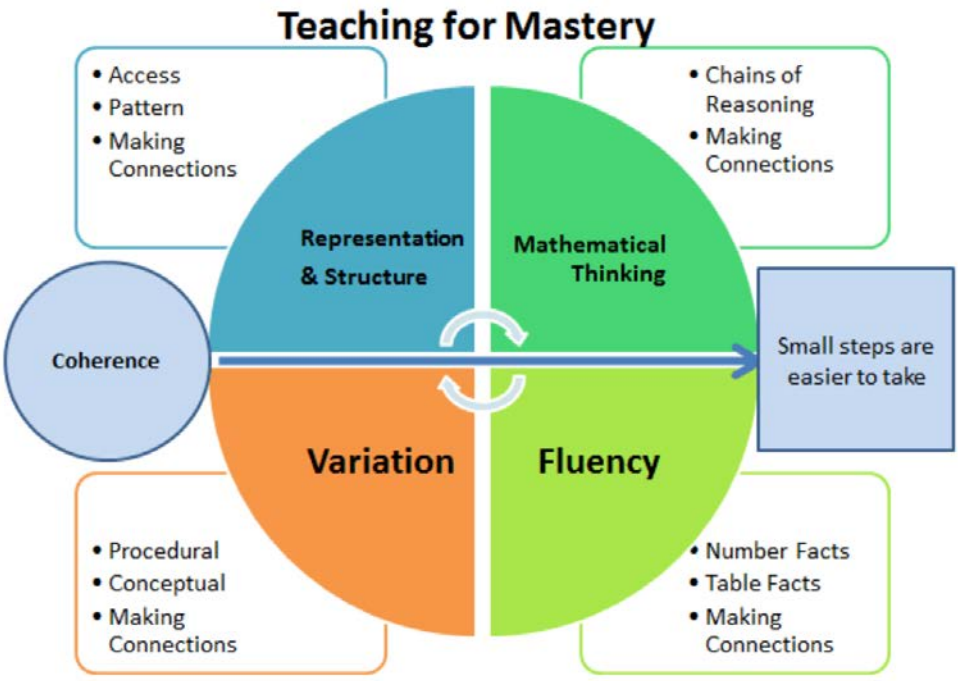


Figure 2: NCETM's five big ideas in 'Teaching for Mastery'

[2] See: https://www.ncetm.org.uk/resources/50042

Currently, little is known about the impacts – in terms of pupil attainment – of the instigation of a mastery approach in England. Large scale trials have only been conducted of one programme, *Mathematics Mastery,* which, when primary and secondary phases are combined, suggest a very small positive effect (Vignoles, Jerrim, & Cowan, 2015). Fully embedding mastery learning in England is likely to be challenging. Rather than clear guidance, schools grapple with translating general principles of mastery learning into practice. To make such a significant change to practice requires significant professional change and a whole school investment in supporting this change through professional development and substantial resourcing.

4.2 Textbook use in England

Recognising the challenges inherent in implementing a mastery approach in primary mathematics, and looking to the practices of the highest performing jurisdictions, the government, through the Maths Hubs (including matched funding being made available to schools to buy textbooks), have promoted the use of quality textbooks to support schools and teachers in implementing a mastery approach.

Textbooks, and other published resources such as worksheets and online apps, might be viewed as "education artefacts" or "tools", central to the work of the mathematics classroom, determining what is taught and when (Pepin & Gueudet, 2014, p.133). This determination may be indirect, merely an influence facilitating teachers' teaching, or it may be more direct, with textbooks adopted exclusively and not supplemented through other material (Pansell & Bjorklund Boistrup, 2018). Beyond content and structure, textbooks can have pedagogical intentions whereby their structure "advances a distinct pedagogical model and is likely to have an impact on actual classroom instruction" (Rezat, 2009, p.1267). This is supported by Fan, Zhu & Miao's (2013) review of textbook research which found that the adoption of different textbooks led to teachers displaying different teaching styles and strategies from those previously used.

Textbooks have the power to exert curricular and pedagogic directions, structuring and controlling the transposition of mathematical knowledge or the translation of policy into practice. This is pertinent in countries where specific textbooks are approved by the country's ministry but also relevant to more free market economies as it repositions control in the mathematics classroom. However, this translation is not simple or linear. Studies and reviews (e.g. Pepin & Gueudet, 2014; Shield & Dole, 2013; Fan, Zhu & Miao, 2013) repeatedly note the agency of the teacher in this translation, reducing the impact countries can have in influencing teacher practice through the imposition of a textbook. Teachers mediate the material, interacting with it in various and sometimes unexpected ways, termed "implementation fidelity" by McNaught, Tarr & Sears (2010, n.p.). Striking differences have been found in the time different teachers allocate to different mathematical and skill content as well as their grouping practices. Gueudet, Pepin & Trouche (2012) argue that this may be more acute where textbooks or resources are available digitally, opening up spaces for adaptation. In terms of analysing textbook usage, this means, as Rezat (2009) has previously argued, that the textbook as an artefact cannot be detached from the ways in which the textbook is used. As Figure 3 shows, all four components – of which textbooks are one – work with, and rely upon, each other. The impact of the textbook does not occur alone, but within the complex interplay of the teacher, student and their mathematical knowledge(s). Therefore, when examining textbook usage, we need to consider the role and activities of the teacher and student.

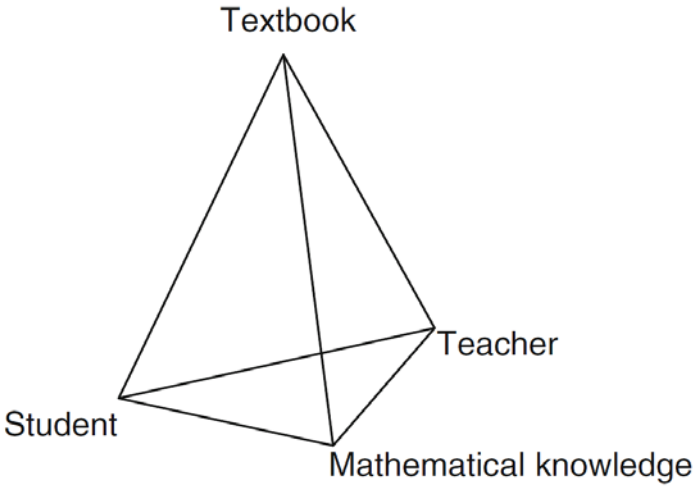


Figure 3: Rezat's (2009, p.1261) tetrahedron-model representing the impact of the mathematics textbook on the activity of learning mathematics as a whole

The last international survey of textbook use was conducted within TIMSS 2007 (Mullis et al., 2008).[3] At that time, internationally, 65% of 4th Grade (ages 9-10) teachers reported using a textbook as the primary basis of their lessons with 30% using it as a supplementary resource. Reported textbook use across selected jurisdictions is shown in Table 1. Of note, England falls into the three jurisdictions reporting the lowest use of textbooks.

Jurisdiction	% of teachers who reported using textbooks to teach maths: Primary source	% of teachers who reported using textbooks to teach maths: Supplementary source	% of teachers who reported that they do not use textbooks to teach maths
England	15	64	21
Singapore	75	24	1
Hong Kong SAR	84	15	2
US	59	33	8
International Average	65	30	5

Table 1: Reported textbook use in selected jurisdictions in TIMSS 2007 (extracted from Mullis et al., 2008)

Historically, textbooks available for use in England have been evaluated as being of poor quality relative to other countries; previously mathematical rules and facts have been presented in an unstructured manner, language was limited or absent, and investigation minimal with a focus on fluent repetition of procedures (Haggarty & Peppin, 2002). Possibly as a result of the poor quality of texts available, textbook use is somewhat controversial in England, particularly in primary schools, with most teachers relying on a vast array of worksheets, often of dubious quality (Askew, Hodgen, Hossain & Bretscher, 2010).

[3] While a later subsequent survey of textbook usage in Grade 9 was conducted, 2007 is the last year in which such data was collated for Grade 4.

A recent national initiative sought to challenge the controversial view of textbook use in primary mathematics, seeking to support primary schools in developing mastery. It promoted the use of textbooks based on the idea that high-quality textbooks underpin mastery teaching internationally (MathsHubs, 2018). Department for Education (DfE) funds were made available to help schools purchase high-quality mathematics textbooks. Unlike the textbooks previous available in England, it was intended that these textbooks would be grounded in mathematical principles, mathematically coherent and carefully constructed. Currently two textbooks have been assessed by the DfE's expert panel as meeting the core criteria for high quality textbooks: Maths No Problem! and Power Maths Key Stage 1.[4]

Given that this initiative is relatively young, substantial and robust evaluations of its effectiveness are yet to be forthcoming. However, trial results are beginning to come through. In 2015, evaluations were published by the NCETM/MathsHub of a trial of the use of Singapore style textbooks, and by Vignoles, Jerrim, and Cowen of the 'Maths Mastery' programme delivered in England by the academy chain ARK. In 2016, an evaluation of Inspire Maths[5], joined this list (Hall, Lindorff & Sammons, 2016). Results of these trials appear positive. All evaluations found small boosts to pupil progress within the first year of implementing a mastery approach in primary classrooms. Beyond this, changes were found in teachers' practices, reflecting 'good practice' and in themselves potentially impacting on pupil progress. Teachers reported increases in their subject knowledge, confidence, and understanding of the role of representations, and found the structures provided by the teacher guides supportive of their planning. Pupils were reported as demonstrating a more "robust understanding of mathematics" than previous cohorts (NCETM, 2015, p.1). There was some difference in how the textbooks were perceived to impact on pupils of different prior attainment. Hall, Lindorff & Sammons (2016) reported that some teachers using Inspire Maths found higher levels of frustration for lower attainers who struggled with the language demands of the textbooks and tended to shut down. Conversely, NCETM (2015) reported that textbook use was seen to benefit those pupils previously labelled as lower-attaining, removing expectations ceilings. They did however raise a concern that supporting the higher-attaining pupils was challenging.

Importantly, a qualitative finding repeated across the textbook trials related to training and professional development, with this being rated highly by teachers and deemed essential if textbooks are going to be used effectively. A similar finding comes out of a very recent comparative study from the US of their newly introduced 'high-quality' textbooks which noted the detrimental impact of limited training in the use of textbooks: here the "average teacher received just one day of training in the current year, and fewer than four days over their entire careers" (Blazar et al., 2019, p.31).

Recent trials are clearly returning some positive results. However, textbooks are not a panacea. The best available research into the use of textbooks per se returns very small effect sizes based on high quality evidence (Hodgen, Foster, Marks & Brown, 2018). Textbook use – particularly as previously seen in England – is strongly mediated by the teacher and the textbook cannot work, or be analysed

[4] The textbook evaluation criteria are available at: http://www.mathshubs.org.uk/media/5559/assessment-criteria-final-09012017.pdf Maths No Problem! was the first textbook approved by the expert panel. Power Maths Key Stage 1 (published by Pearson) joined the approved list in 2018. It is aligned with the White Rose schemes of learning.

[5] Inspire Maths is the UK edition of My Pals Are Here! first launched in January 2015 by Oxford University Press.

as an artefact, absent of the teachers' influence, again reiterating the important role of training and whole school development in bringing about change.

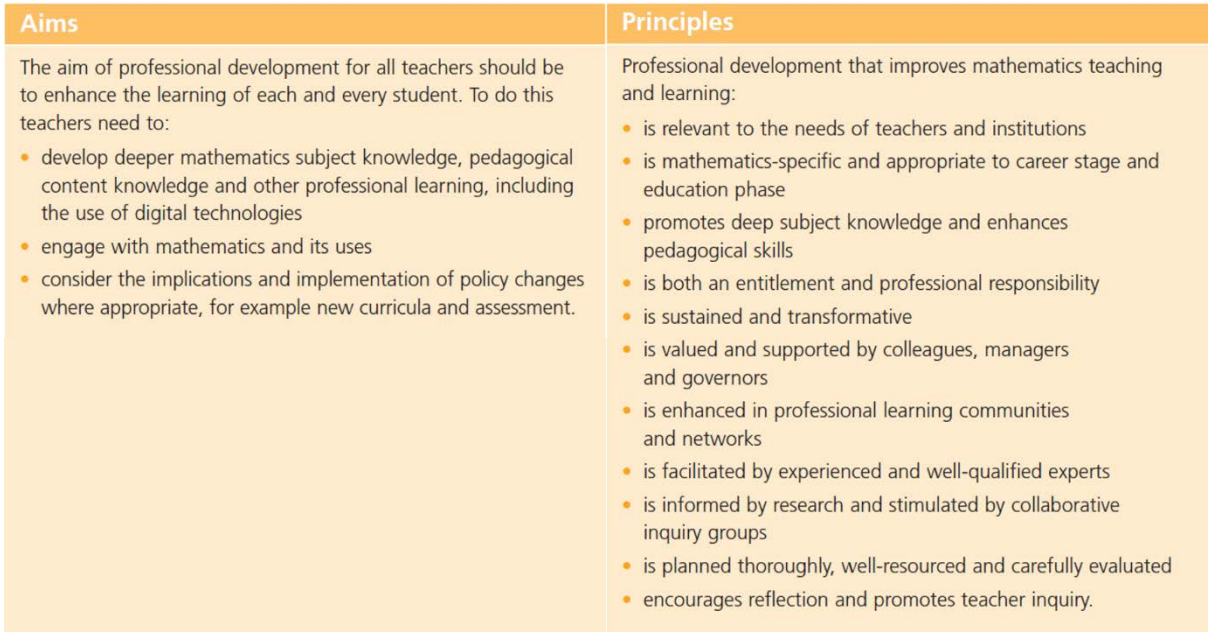
4.3 Whole-school change and professional development

Across all approaches to mathematics teaching, the role of the teacher is crucial to the success of the selected strategies and interventions (Hodgen, Foster, Marks, & Brown, 2018). Hence, the teachers' training and development, and that of the school within which they work, are likely to be central to whether the implementation of any approach – such as mastery – is successful. If a primary school has made the decision to adopt one of the new high-quality mastery textbooks, they are also buying into a mastery approach to mathematics teaching in their school. Both the academic and professional literatures note the significant investments required – financially, but also of time, energy and emotion – as a whole school if implementation is to be successful (Clapham & Vickers, 2018; Pearson Primary, 2019).

Establishing effective CPD is known to be complex; it reflects teaching which itself is complex. The Centre for the Use of Research and Evidence in Education (CuREE) classify CPD into four categories, which become progressively sophisticated: 'informing', 'influencing', 'embedding', and 'transforming' (Cordingley, Buckler & Isham, 2012, p.4). While at the lowest level – informing – participants are given new information, it is only at the higher levels – embedding and transforming – where changes to practice are seen. The authors state that CPD must be at these higher levels for "significant and far reaching professional learning and substantial enhancement of pupil learning" to occur (*ibid*., p4). Unsurprisingly, the average costs and time commitments rise across the levels of sophistication. Experience has shown that for CPD to be transformative it needs to be sustained, offering participants the opportunities to reflect and explore ideas in their classrooms. This suggests that if a school makes the decision to take on a mastery approach to primary mathematics, the implications for CPD are not insignificant and must be factored into the decisions made at all stages.

In response to concerns over the CPD available to mathematics teachers (at all stages) the Advisory Committee on Mathematics Education (ACME) published two reports, one in 2002 and a follow-up a decade later in 2013 examining the nature and challenges of CPD and making recommendations for future practice. Their aims and principles (see Figure 4) provide a useful starting point to schools in assessing their CPD needs and in reflecting on its effectiveness. As CPD moves from the more traditional providers (e.g. local authorities, HEIs) towards various private and professional networks (publishers, academy chains) (ACME, 2013, p.2), these may also provide something of a benchmark, ensuring the different elements needed by different teachers as a school moves towards a mastery approach are considered.

A key focus of CPD for primary teachers in a school embarking on a mastery approach must be on pedagogical and subject knowledge. Such knowledge is shown to be crucial in realising the potential of mathematics curriculum resources and interventions to raise attainment (Coe et al., 2014). Therefore, if individual teachers – and schools as a whole – are to realise the potential of textbooks within a mastery approach, it follows that at least part of the emphasis on ongoing teacher CPD should be on pedagogical knowledge. This is reiterated by Pearson Primary (2019) who note that the elements underpinning mastery – a logical structure of small connected steps and the careful use of structures and representations – may be challenging to non-specialist teachers and hence CPD is vital.



Aims	Principles
The aim of professional development for all teachers should be to enhance the learning of each and every student. To do this teachers need to: • develop deeper mathematics subject knowledge, pedagogical content knowledge and other professional learning, including the use of digital technologies • engage with mathematics and its uses • consider the implications and implementation of policy changes where appropriate, for example new curricula and assessment.	Professional development that improves mathematics teaching and learning: • is relevant to the needs of teachers and institutions • is mathematics-specific and appropriate to career stage and education phase • promotes deep subject knowledge and enhances pedagogical skills • is both an entitlement and professional responsibility • is sustained and transformative • is valued and supported by colleagues, managers and governors • is enhanced in professional learning communities and networks • is facilitated by experienced and well-qualified experts • is informed by research and stimulated by collaborative inquiry groups • is planned thoroughly, well-resourced and carefully evaluated • encourages reflection and promotes teacher inquiry.

Figure 4: The Advisory Committee on Mathematics Education: aims and principles of effective CPD (ACME, 2013, p.4)

5 Methodology

This research took the form of a small-scale multi-site case-study. This approach was deemed appropriate as it enabled us to ascertain the commonalities around textbook usage as well as identify 'telling cases' (Mitchell, 1984), i.e. points of interest which may be unique to a particular case but which have something important to tell to the overall picture.

5.1 Sample

We established that four schools would be feasible and would provide us with a suitable dataset to address the research questions. Our requirements for each school were that they used a mastery textbook for the majority of their mathematics teaching, had done so for at least a full academic year and that they had an NQT who was willing to be involved in the study. We sent recruitment invites to schools across our ITE partnership and other training schools and to our ITT and MaST alumni (who were now, respectively, either NQTs or subject leaders). We received an overwhelmingly positive response, with 21 schools expressing an interest in being part of the research. From these schools, we made our selection based on the textbook being used (providing a range and allowing us to explore whether specific textbooks or the use of textbooks per se might account for any observations made), how embedded textbook use was in the school and on location (all schools were in urban locations in the South-East of England).

Within each school we focussed our research on the NQT and on the mathematics subject leader, i.e. a total of eight participants across all schools. The final sample and pseudonyms given are detailed in Table 2.

School pseudonym	NOR	Textbook used (and years used)	NQT	Year group NQT teaches	Maths Subject Leader (MSL)
Averford Primary	537	Maths No Problem! (3 years)	Taylor	3 (ages 7-8)	Jamie
Ebbsbrook Primary	548	Maths No Problem! (3 years)	Sam	3 (ages 7-8)	Frankie
Newbeck Town Primary	192	White Rose (2 years)	Daryl	5 (ages 9-10)	Bobbie
Seabridge Primary	591	Inspire Maths (3 years)	Phil	4 (ages 8-9)	Stevie

Table 2: Sample of schools, NQTs and MSLs in study

5.2 Data collection methods

Site visits were made by two members of the research team. At each site we conducted an observation of the NQT teaching using the school's selected textbook, an interview with the NQT, an interview with the mathematics subject lead, and where available, a scrutiny of the school's mathematics or calculation policy. Details of each data collection method are given in Table 3.

Data Collection	Participants	Focus	Length	Data capturing
Lesson observations	NQTs	Observations focused on: • Identifying features of a mastery approach evident in teaching; • How the NQT integrated textbooks into their classroom teaching; • Use of supplementary materials; • Use of resources / representations.	One, approx. one-hour lesson per NQT	Field notes captured on observation schedule and used to support discussion in interview
Individual interviews	NQTs	Semi-structured interviews were timetabled to take place after the observed lesson allowing features of the lesson to be discussed. The interviews focused on NQTs': • Understanding of mastery and where this originates; • Understanding of the role of textbooks; • Experience of training in mastery and in using textbooks effectively; • Linkage between the theory of mathematics teaching and their textbook / teaching approach.	One 40 minute interview per NQT	Interviews were audio recorded and fully transcribed for analysis
	Mathematics subject leaders (SL)	Semi-structured interviews with the mathematics SL took place on the same day. With a strong focus on training / CPD, these interviews explored: • Reasons underpinned the school's decision to buy a selected textbook; • Previous and ongoing CPD available to staff in using textbooks; • Training available for NQTs to support textbook use; • Mastery / other mathematics training undertaken by staff.	One 40-60 minute interview per MSL	Interviews were audio recorded and fully transcribed for analysis
Scrutiny of mathematics policies	N/A	Policies were scrutinised to explore how mastery was described, reference to the use of a textbook and for directed pedagogic approaches.	N/A	Notes were compiled and cross-referenced

Table 3: Overview of data collection methods

5.3 Data analysis methods

Following the data-collection process we had eight fully transcribed interviews, supplemented with observation and policy scrutiny notes. The research team initially developed a theoretically-derived coding scheme. Transcripts were then coded by two members of the research team using this scheme which was further developed inductively as themes arose from the data. New codes were agreed and added to the coding structure, allowing for the development of a unified coding scheme (see Appendix C). Following this, the two researchers independently coded the same transcript, demonstrating a high inter-coder reliability of 91%. Further, ongoing notes and discussions between the researchers ensured codes were applied in a similar way to one another.

After the interviews were coded, the research team looked at instances of each code group in order to look for broader themes and patterns within the coded data, such as repetition or absence. These themes and patterns were used to build an understanding of how NQTs were using, and were supported to use, a mastery approach, with a particular focus on the use of textbooks, and if/how they translated mathematics education theory into the classroom. Verbatim quotations were identified to exemplify the central themes emerging.

5.4 Ethics

This project was conducted with full adherence to the University of Brighton Ethics Guidelines and the BERA (2018) Ethical Guidelines for Educational Research (4th edition). Ethical approval was sought prior to the commencement of the project (see Appendix A: Ethical approval for project). School sites and participants were approached via a gate-keeper (usually the Head-teacher or Mathematic Subject Leader). All participants were provided with information sheets and completed consent forms which detailed what their participation would involve, how their data would be used and their right to withdrawal.

6 Project Findings

In this section we present the key findings of our study in relation to the three research questions. As noted in Section 5.3, we examined the patterns – and the strength of these patterns – emerging within each theme. These key concepts are then illustrated through quotations from the NQTs and MSLs. It is important to note that although we present patterns within themes, these were not always so clear-cut; as such, we note where concepts emerging transcended two or three themes.

In order to gain a broad sense of what was important to the NQTs in talking about their use of textbooks and mastery, we conducted a content analysis across their transcripts. A Tree-Map of the 50 most common primary words (i.e. removing common words such as ‘because’) – where the area of the rectangle represents the frequency of the word being used is shown in Appendix B: Tree Map of NQT interview utterances. While only providing a broad-brush indication, some interesting comparisons arise:

- *Understanding* is talked about more than *knowledge and skills*
- *Questioning, learning*, and *depth* appear significantly more important than *practice*
- *Thinking, together* and *talk* seem more important than *explaining* and *guiding*
- The language of *togetherness* appears more strongly than the language of *ability*

These, and other emerging patterns, are now discussed in relation to the three questions of this research.

6.1 Conceptualising and implementing mastery

The NQTs who participated in this study described a complex and interconnected understanding of mastery and, as indicated in the literature review, conceptualise mastery as both a goal and an approach.

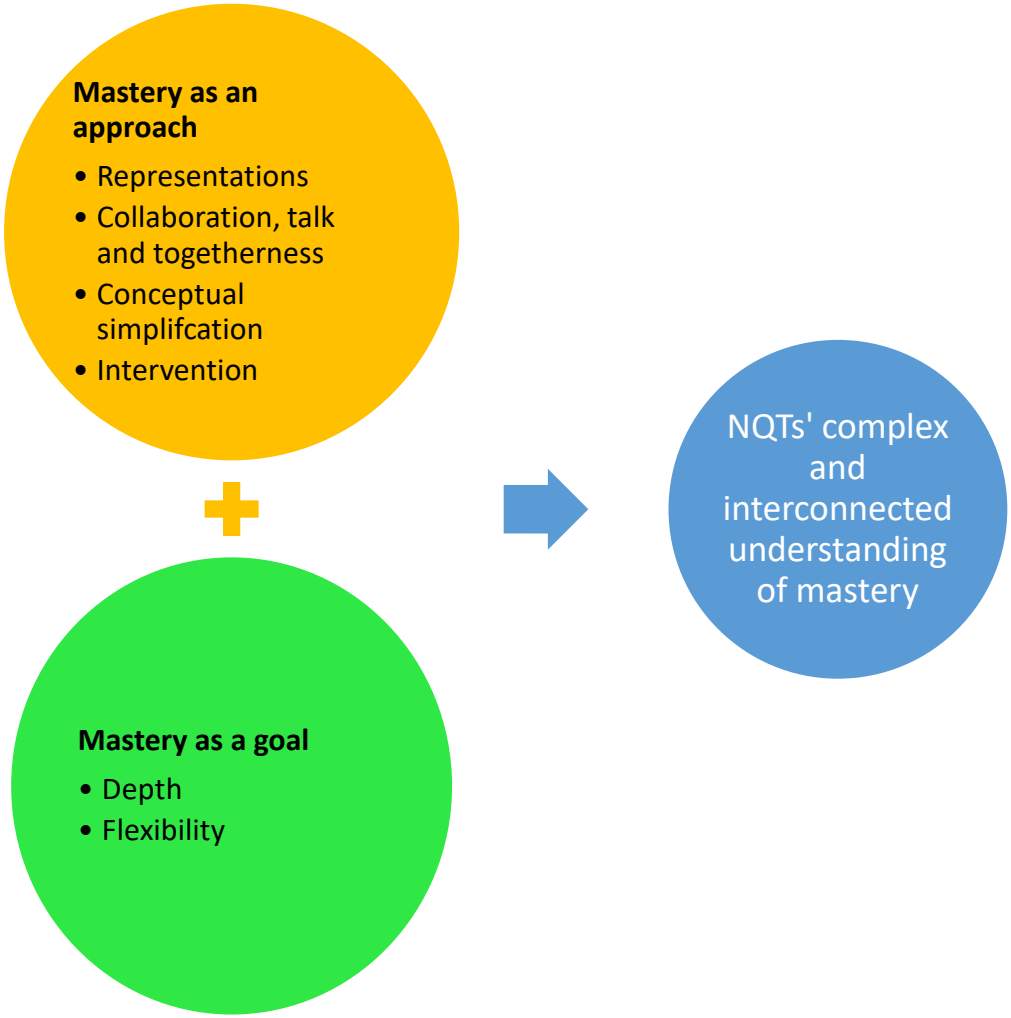


Figure 5: NQTs' conceptions of mastery

6.1.1 Understanding of mastery as a goal

When considering mastery as a goal, there was common reference to 'depth' which NQTs interpreted to mean children understanding 'why' or making connections:

> "Mastery [is] their deeper understanding and to know why they're doing what they're doing" (Taylor, MNP)
>
> "getting the children to not just write down a fixed answer and say that 'I know the answer,' but actually getting them to explain how they did it and why they did it" (Sam, MNP)

Related to this was evidence of the NQTs' intention to enable children to develop flexible approaches to solving.

> "it's promoting different ways of thinking rather than just I need to follow these steps to get the answer" (Phil, Inspire)

Of note was the absence of significant reference to other elements of mathematics learning which might be sought, such as the development of knowledge of facts or procedures, or strategies for extended problem-solving.

6.1.2 Understanding of mastery as a teaching approach

6.1.2.1 Mathematical representation

As an approach to teaching, the theme of mathematical representation was reflected in all NQT interviews as a component of mastery and the development of understanding.

> "[with resources] they could see, they could make that connection" (Taylor, MNP)
>
> "if you understand it by manipulating, let's transfer it then to a picture, does it still work? Let's transfer it to symbolic, does it still work? Yes, it does. And I think it really, really helps… I think it's always good to see things in different ways, different forms" (Daryl, WR)

Taylor and Daryl relate the use of mathematical manipulatives to acts of understanding. Taylor does so by equating 'seeing' with being able to make connections, whereas Daryl focuses on making connections between different modes of representation (here referred to as manipulating, pictures, and the symbolic).

Connected to this was NQTs' understanding of the transition from working with manipulatives to symbols, which was associated with a pathway to 'depth':

> "for those children who are not understanding more complex processes it's useful to have that equipment to build them up to the abstract level" (Phil, Inspire)
>
> "if they can prove it with resources, they've got a really good deep understanding" (Taylor, MNP)

6.1.2.2 Keeping the class together

A further significant theme was the importance of keeping the class 'together'. All NQTs in this study understood mastery as an approach in which all children were engaged in the same or similar learning and seated in mixed-attainment groups. They understood collaboration and pupil talk to benefit learning but gave different reasons for this:

> "I wanted them to… talk to other people around them because I thought they'd come up with completely different things" (Phil, Inspire)
>
> "When they're part of a collaborative group it might be that you have to argue why you think actually yours is the right answer" (Daryl, WR)

Here Phil and Daryl justify the use of mixed-attainment grouping in different ways; Phil values multiple perspectives while Daryl focuses instead on the opportunities for mathematical argument such groupings present.

Mixed-attainment groupings were understood to have particular benefits for lower attainers:

> "I just think if you put same ability pairs together, … the children that struggle with maths, they'll just sit there and neither one of them will be able to start the conversation…but actually having the mixed ability pairs can help … for the ones that need that support, they've got someone there to help them" (Taylor, MNP)

Here Taylor's focus is on seating children such that all have access to talk.

6.1.2.3 Representations for differentiation

However the NQTs understood mixed-attainment grouping, this approach presented them with a problem, namely how to address the same learning outcomes for all children while also ensuring the learning is pitched at an appropriate level for each individual. The NQTs approached this by employing mathematical representation not only as a tool for developing understanding, but as a means of providing both support and challenge.

> "it's about all the children having the same learning intention but giving them the different resources to be able to get there" (Taylor, MNP)
>
> "for the greater depth [group of children], to make sure they're challenged during this point, I'll say 'Can you use a bar model to represent the problem?'" (Sam, MNP)

Here Taylor describes using various forms of mathematical representations to enable all children to 'get there' and achieve the same learning outcome. Similarly, Sam directs children to formulate their own representations as a means of challenging them. Thus the NQTs in this study go beyond understanding representation as a means of developing understanding to using it as a method of differentiation.

Differentiation might be interpreted to mean ensuring in each lesson all children make progress in a general way, perhaps with different groups working towards differentiated learning outcomes. This view was not evident in the interviews. Instead, the use of representations as a tool for differentiation was understood to ensure all children met the same learning outcomes.

> "They're still doing the same thing, but they're just given more support or more resources or extra input to be able to do it" (Taylor, MNP)

6.1.2.4 Conceptual simplification

An additional and related response to managing mixed-attainment grouping was NQTs' understanding of the way elements of the lesson could be simplified.

> "To make them understand [the lesson objective] I had to simplify… the simpler nature of it means that you can… everyone's understanding it" (Daryl, WR)

There was a lack of evidence, however, of the specific ways NQTs in this study decided to simplify elements of their lessons or their evaluation of its impact.

> "they [lower-attaining pupils] had the same learning intention, but actually they had slightly smaller numbers to be working with, but they're still solving word problems using division" (Taylor, MNP)

For example, the careful selection of numbers to remove potential barriers to learning was not raised, and in the quote above the nature of the simplification described is general ('slightly smaller numbers'). This is mirrored in the absence of significant reference to mathematical variation

(Hodgen, Monaghan, Shen & Staneff, 2014) or appreciation of representation of mathematical 'structure' (NCETM, 2016).

6.1.2.5 Intervention

In order to manage mixed-attainment grouping, the NQTs also recognised the importance of readying children for subsequent lessons and understood intervention as an element of a mastery approach:

> "when I look at the children's maths books at lunch I'll identify any children that have really struggled this morning that I haven't picked up in the lesson or that I think need a little bit more support and they'll have over learning this afternoon" (Taylor, MNP)
>
> "they'll then come to same day intervention this afternoon and then hopefully I can then pre-teach a bit of tomorrow before then we move on" (Daryl, WR)

It is important to note that despite the NQTs' desire and willingness to evoke mixed-attainment teaching, they were not always able to find ways to ensure all children could access the same learning outcomes and in some cases teaching assistants (TAs) were deployed to provide alternative provision:

> "They are on the SEN register and they're working at year two level. So they go out with a TA" (Sam, MNP)
>
> "the group with my TA are significantly lower, so they have completely different questions, so they did need to be separate" (Taylor, MNP)

Catering for the needs of all children, including those with extremely low prior attainment, was a concern for the NQTs and exploring approaches to this forms part of our recommendations in Section 7.

6.2 Using a 'mastery' textbook

In this section we examine how the NQTs sought to mesh the requirements of the textbook with other school requirements and consider the training they received (as well as that received by other school staff) to support the development of textbook use within their mathematics teaching practice.

6.2.1 Integrating textbooks: structure

A recurring feature of the way textbooks support NQTs in translating theory into practice is that of providing structure. Textbooks offer structure both in the way that learning is organised over time, and in how learning is structured within individual lessons. Operating within these structures provided the NQTS with a strong degree of security.

"so that's what I think's quite good about this scheme, is that right from reception to year six it's all laid out with what they learn in the same order… it's a rigid structure, but it does just work" (Sam, MNP)

"the textbook gets progressively harder in each topic because it starts with the fluency and then it always ends with the word problems" (Taylor, MNP)

Sam and Taylor, both using MNP!, focused on different aspects of the textbook's structure: Sam notes a consistency of approach to medium term planning; Taylor focuses on the progression of difficulty embedded within each topic. To an extent these findings echo those of previous research in indicating that textbook use impacts on what is taught and when (Pepin & Gueudet, 2014), however this is seen as supportive rather than straitjacketing, enabling the NQTs to make pedagogical decisions within a safe framework:

"coming into a new school, a year group I've never taught in before and it's my first year of teaching, it is really useful to have a structure that says here's the progression, this is what we're trying to get to… I'd have a lot more questions and doubts over what I should be doing and what I should be teaching if I didn't have the textbook" (Phil, Inspire)

"So before [the textbook covered] area and perimeter we learnt the skills that actually would then feed into area and perimeter by doing a little bit of multiplication beforehand" (Daryl, WR)

Here Phil connects the structure provided by textbooks to the particular circumstances often faced by NQTs: an unfamiliar class, unfamiliar year group and limited experiences on which to base pedagogic decisions. In contrast, Daryl highlights the connection observed between topics reflecting confidence that learning though the textbook is progressive and coherent. Thus, for these NQTs, the textbook supports their decision making and removes some of the many uncertainties they face in their first year of teaching.

Lesson structure was a feature addressed by the three NQTs whose schools are using a hard-copy textbook rather than an online scheme:

"we kind of follow a similar structure each lesson" (Taylor, MNP)

In all these cases, NQTs described how organisation of each lesson was drawn from the textbook with some specific school agreed practices that took account of school or year group circumstances. NQTs' descriptions of lesson structure reflect confidence with the organisation and importantly the purpose of different aspects of the lesson in supporting learning and assessment.

6.2.2 Teacher autonomy

NQTs recognised the balance that needed to be struck between following the recommendation of the textbook and drawing on their own decision making. Their sense of autonomy in not being bound by the textbook together with a clear sense of being responsible for decision making is evident:

"We tend to build on it in our planning. We'd say 'Well, the textbook has suggested this way and this terminology… How are we going to use it? What do you think our classes will respond well to?'" (Phil, Inspire)

"The point isn't that you just take it [the outline on the scheme website] and you just use that. It's just a short paragraph written about what the aim of that lesson is and then we put it into this format [school lesson plan template] with those key questions. So it's designed for you to not copy and paste" (Sam, MNP)

This expectation of, and recognition of the importance of, teacher autonomy in mediating the textbook's use is echoed by the MSLs:

"I didn't want to be like "You must do it this way, then this way, then this way." I wanted them to be able to get it to work for themselves and still be able to be an individual teacher and not have to be a robot and do it in a certain way" (Jamie, MNP)

There is no sense on either the part of the NQTs or MSLs of the teacher's role being reduced to that of a 'technician' (Boyd, & Ash, 2018, p.221) as a result of the use of a textbook. The full involvement of NQTs alongside more experienced teachers in actively mediating and making decisions about how the textbook or online scheme is used is evident across all interviews. From the perspective of MSLs the positive impact on teacher development through textbook use, (a theme revisited in section 6.4), is noted explicitly by both Frankie and Stevie:

"and that's why people's subject knowledge has developed so much because they had to think for themselves. It hasn't been 'Do this, do this'" (Frankie, MNP)

"they saw what skills they still needed to deliver these materials and in fact they realised that they needed to be a better maths teacher in order to deliver these materials" (Stevie, Inspire)

Although NQTs noted how lesson sequences made small alterations in conceptual complexity, they did not draw out understanding of other features of the textbooks such as the careful selection of worked examples or the appreciation of mathematical structure. This perhaps highlights an area yet to be fully appreciated by NQTs; unsurprising given their current experience.

The use of the textbook did bring with it an occasional feeling of constraint. Being behind where the class should be – particularly in a multi-form entry school – generated some discomfort:

"there is that sort of expectation to be broadly in line with the other two classes… there'll be numerous afternoons that we spend catching up on something" (Phil, Inspire)

Further, the textbook itself could promote similar feeling, for example where a class were not progressing as the termly overview suggested they should be:

"Actually I should be on fractions now…it's a forever chase your tail, am I getting it done in time?" (Daryl, WR)

These comments were specific to the two NQTs above; overall the evidence from interviews with both NQTs and MSLs reflects a strong sense of both autonomy in decision making coupled with clear support of a structured approach arising from the use of the textbook. Indeed across all schools, NQTs' responses suggested that the use of the textbook provided support for particular aspects of their practice:

"I already feel confident in knowing that wording [of questions] is the best for their learning at the moment […] using this [textbook] I know that this is exactly where they need to be" (Sam, MNP)

"I do find the review probably one of the most useful parts of the lesson actually" (Taylor, MNP)

For Sam, the pitching of questions and the use of vocabulary is rendered more secure through the guidance of the textbook; for Taylor a particular phase of the lesson was supportive in developing assessment practice. Support for assessment, and confidence in decision making arising from assessment is echoed by both Daryl and Phil:

"I knew that there needed to be something else in between that for them to work out how to do it" (Daryl, WR)

"I'm fairly content with that because if they have that solid understanding of why we're doing that, hopefully we can then start building on the more complicated questions afterwards" (Phil, Inspire)

6.2.3 Training and CPD

The NQTs in this study all joined schools where the chosen mathematics textbook had already been introduced. For all schools this earlier introduction had included significant staff training, prior to the NQT joining the school, including ongoing staff development meetings. For those using hard-copy textbooks, it had also included intensive publisher-led training. In these cases, the MSLs initially received this publisher led training; they then led INSET and ongoing staff development meetings for the whole staff team. In the case of Ebbsbrook school, as more teachers attended publisher-led intensive training, a larger pool of staff members also shared the lead of staff development meetings. At Seabridge, a trainer from the publisher has also recently been bought in to lead in-school training for key staff across the academy chain. Despite the relatively similar period of time since the textbook had been introduced for these three schools, we note significant variability in the number of staff in the schools receiving intensive publisher-led training, ranging from the MSL alone attending from Averford school, to Ebbsbrook where all teachers except the NQT had already received intensive training from the textbook publishers. While the reasons for this variability did not emerge in the interviews, Ebbsbrook's MSL viewed the sustained investment in intensive publisher-led training as part of the success of the implementation of the textbook:

"So when you get to go you meet the person [who devised the textbook], which helps you. You sort of buy into it all because you run into him... everybody has said it's the best CPD they've had" (Frankie, MNP)

Conversely at Averford, the MSL identified potential challenges where insufficient understanding of the textbook's underpinning structure and approach is not sufficiently secure:

"We're very lucky that we've got Maths No Problem! and you're all embedding the mastery principles, but you may not know that you're embedding the mastery principles. […] So when we're analysing the textbooks to say, you know, 'Actually I don't think they need that question or I don't think that question is relevant,' to the untrained eye they might not be relevant, but actually when you analyse the reasons why the questions are ordered specifically like that, there is a reason behind it. And that's the bit where we're trying to get staff thinking more carefully about why Maths No Problem! has ordered the questions like they have. Because what might seem quite easy at the beginning, some staff will be like 'Oh, okay, well some of my children don't need to do those first few questions,' but actually they do because those are setting the foundations to be able to work out the next few questions" (Jamie, MNP)

While this response was not specifically linked to the question of intensive publisher-led training, it does highlight the need for a shared understanding of the textbook, its organisation and rationale. Where a large proportion of staff from a school have attended this intensive training, arguably this wider spread understanding is likely to support greater consistency in the approach to use of the textbook. Where training is limited to one or a small number of staff, their responsibility for establishing this shared understanding and a whole school approach is significant.

Across all four schools, staff development was ongoing, a feature noted in the literature to be vital for successful implementation (Clapham & Vickers, 2018; Pearson Primary, 2019). However, an important difference emerging between schools was the extent to which this ongoing training still had a publisher led component. Rather than differences emerging between the use of different text books, data from this study suggests that commitment to ongoing publisher led, in addition to school led, staff training, facilitating a whole staff team shared understanding, is a significant factor in enabling NQTs to develop confidence and secure understanding in their use of the text book, whichever mastery text book is selected. This long term investment in publisher led training is noted by one MSL:

> "It's not going to be something that stands still. It has to keep on developing and the training has to stay up" (Stevie, Inspire)

School led training reflected the ongoing development needs of the staff team and in line with recommendations from literature (Coe et al., 2014), focuses on subject and pedagogical knowledge. One school was focusing on assessment, a second on developing mathematical generality, while the other two were focusing on aspects of the use of representations. This facility to be responsive to staff needs is also important as implementation proceeds. For NQTs these ongoing staff meetings enabled the focus on mathematics to be maintained:

> "Jamie [MSL] does quite a lot of staff meetings, which is quite good, so it's constantly ticking over" (Taylor, MNP)
>
> "We've had so many staff meetings now that have been mastery approach based" (Daryl, WR)

Aside from staff meetings, all NQTs talked positively of the individualised support they received. This might be from their NQT mentor, the MSL or their year group colleagues. This support was wide-ranging, including team teaching, observing the MSL or other colleagues, watching videos of colleagues teaching, being observed, one-to-one planning and discussion with the MSL, collaborative (year group) planning, ongoing conversations and drop-in advice. It is evident that MSLs, mentors and year group colleagues invested significant time in the development of and support for the NQTs in their schools specifically in order to support them to use the textbooks.

> "They were very good at devoting time to help me because they'd used it before and they wanted to tell me how they did it so we'd all be on the same page" (Phil, Inspire)
>
> "We did a lot of team teaching at the beginning. I had someone come in my classroom once a week to team teach Maths No Problem!, which is so helpful" (Sam, MNP)

The support provided for NQTs appears to attain the highest categories of CPD identified by Cordingley, Buckler & Isham (2012): 'embedding' and 'transforming'. The ongoing staff meetings supporting professional change across the staff team. For NQTs, the ongoing focus on mathematics development and the opportunity to work with colleagues is enabling them to develop confidence.

Possibly indicative of transformative change, NQT responses reflect that they are part of shaping new approaches within their schools:

> "We kind of looked at that [generalisations] as a whole staff, which was really good and an opportunity to actually to discuss it with other year groups as well…..so it's consistent across the school" (Taylor, MNP)

Here, both Taylor describes a collaborative development, not an exchange where the NQT is the recipient of advice. The structure and recommendations of the textbook provide a focus around which pedagogical discussions are regularly held, as school teams, including the NQTs, seek to maximise the impact of textbook use on children's learning.

6.3 Translating theory into practice

In this section we examine the NQTs' understanding of the theoretical drivers of the textbook design, their prior understanding of mastery and the next steps in their learning.

6.3.1 Theoretical underpinnings of mastery textbooks

Interviews with NQTs revealed explicit awareness of some connections between theory and practice in their use of textbooks yet omitted features equally worthy of note. In relation to the former, all NQTs spoke of the importance of the use of representations, some explicitly making a connection between Bruner's (1966) theory of representation and the use of enactive, iconic and symbolic representation of mathematical ideas, and the 'concrete, pictorial, abstract' approach that is characteristic of Mastery teaching. For some NQTs, this was heavily influenced by the focus on the use of representation during their ITT which provided them with a theoretical foundation for the use of resources in their mathematics teaching:

> "And the lessons [at university] were always resource based… when we had our seminars she'd [the tutor] always have trays straightaway already on the table, resources already out, and then when we worked through questions she would be giving suggestions about different resources we could use" (Sam, MNP)
>
> "I did an undergrad in education beforehand, so Bruner obviously gets thrown in there…and then it was very big at university [PGCE year] that it was spoken about in all different forms of representation" (Phil, Inspire)

Resource use was a strong feature in all lessons observed and all four NQTs spoke confidently of the benefits of their use (see 6.1.1 and 6.1.2). Use of representations is a key part of the embedding of a mastery approach; NQTs' recent ITT experience supported a smooth transition to the use of resources as part of the textbook. For more experienced teachers the textbook's recommendation of the use of representations provides validation of this approach:

> "With Maths No Problem! when teachers were looking in the workbooks and textbooks, they were like 'Oh, this is fantastic, I can see I've got to use Dienes, I can see I must use place value counters'" (Jamie, MNP)

It also provided a strong steer for other experienced teachers where the use of resources may not previously have been frequent practice:

"And where teachers were less likely to use resources, they couldn't get away from using the resources now because the textbook shows pictures of them and it showed them that the children needed to be using them. So it was really good for teacher subject knowledge as well" (Jamie, MNP)

A second clear link with theory arises in NQTs' reference to the importance of a pedagogical focus on understanding as well as a focus on competence in processes, linked to Skemp's (1976) work on relational vs instrumental understanding, and to their understanding of mastery as aiming for depth of understanding (see 6.1.1):

"She [SCITT tutor] emphasised the fact that children need to be able to know what they're doing and understand why they're doing things" (Taylor, MNP)

"So I think my training last year combined with this textbook do make me think more deeply of am I just getting them to find the answer or am I helping them to understand the process behind it" (Phil, Inspire)

This awareness of the need for children to have time to deepen their understanding was evident in all NQT interviews and underpinned the confidence to adjust lessons to better meet the needs of their class. They felt that the textbook supported them in doing this. Allied to this was an awareness of the connected nature of the textbook noted earlier in section 6.2.1 which presented learning progressively and in ways that enabled skills to be revisited frequently in different contexts. For both NQT and MSL at Ebbsbrook this was explicitly linked to spiral learning theory:

"We do a lot of spiral learning, so even though we have units of multiplication and length etc., everything is linked into each other. We're always coming back to it. Maybe they didn't understand about exchanging when we were learning about addition, but then we've done it again in weight and then they were ready to learn. So you keep coming back to it all the time, keep deepening their understanding" (Jamie, MNP)

6.3.2 Preparation and future learning needs

Specific input on mastery as part of ITT was variable. Reflecting Williams' (2019) argument, Sam felt that ITT mathematics instruction was overtly underpinned with its connections to mastery. However, in some cases this needed to be made more transparent for trainees:

"At university our teaching of maths was definitely based on mastery and we heard that approach a lot, that kind of thread through all of what we were learning about" (Sam, MNP)

"We're kind of doing it at uni and then you do these things like White Rose, but no one ever says to you that they're part of the same thing" (Daryl, WR)

Other aspects of theory underpinning a mastery approach were not drawn out in interviews with NQTs. For example, while NQTs described the small steps taken as part of their textbook approaches, an understanding of how this built over time into a coherent whole was not evident; though faith that it would was clearly reported (see 6.2.1). Secondly, the use of procedural and conceptual variation appeared to be less well understood:

"It rings a bell, but I couldn't explain it, no" (Phil, Inspire)

"Our NQT will be able to plan and resource a lesson really well, all supported by the Maths No Problem!, but may not know that the questions are set out with procedural variation"(Jamie, MNP)

However, given that MSLs identified variation as a development area across staff teams, with some evident conflation of variation and variety, it is arguably unreasonable to expect that for NQTs this aspect of the mastery approach could be embedded and coherently understood so early on in their teaching career:

> "And that's the bit where we're trying to get staff thinking more carefully about why Maths No Problem! has ordered the questions like they have" (Jamie, MNP)
>
> "I think that's something that we're trying to embed, but we're quite early on in that journey of actually understanding what that really means" (Bobbie, WR)

For the MSLs in the two schools using MNP! it is important not to underestimate the significance of the evident and strong theoretical underpinning of the mastery approach as reflected in the textbook's approach. Both MSLs readily identified these underpinnings; moreover, it was a significant part of their faith in the textbook, and their evaluation of quality:

> "There's lots of different theory connections that we can make. Skemp and Bruner are probably the two that I would refer to most, but there's then lots more recent research" (Jamie, MNP)
>
> "And you believe in it so much because you couldn't not [do so] from this research" (Frankie, MNP)

The final comment in this section exemplifies the importance not just of a theoretical underpinning, but effective communication of this underpinning in supporting schools to use and embed the principles on which the textbook is founded. Here Frankie speaks of the quality of the publisher-led intensive training:

> "Do you know what I liked about it the most? Is that it wasn't - out of the day this is the section on the theory…he [the textbook's deviser] is continuously referring back to theorists that you learn about when you're at university and then you're in the real world of teaching, but he constantly goes back to "Oh, this is because of Vygotsky, this links to this, this, this" and pieces everything together" (Frankie, MNP)

6.4 Affordances and constraints of using textbooks to implement a mastery approach

Across the interviews, both with NQTs and MSLs, affordances and constraints in implementing a mastery approach to the teaching of mathematics in primary schools – and in particular using a textbook to support this – came to the fore.

6.4.1 Affordances

While staff-training was found to be supportive, it was the smaller elements of the whole-school approach / provision which proved enabling in bringing staff 'on board'. For example, the introduction of systematic intervention afforded improved staff buy-in:

"In the second term when I'd made the decision about the pre-teaching, that's when it all started to calm down and people, particularly the vocal ones, changed their minds completely and I had lots of conversations with those staff going 'This is brilliant. This is the best thing ever. As long as you're not going to get rid of this, as long as this is staying, we really see what is happening here'" (Stevie, Inspire)

The materials and coherent structure provided by the textbooks used by the schools afforded improved use of time by teachers which may also have impacted on staff attitudes towards the adoption of a mastery approach:

"It saves time, for one. We haven't got to make up the resources that we need to all the time….it's just a nice way of having a bank of stuff to go to, I think" (Taylor, MNP)

"it's cut their workload… I love it. You know, why can you not love this? It makes the children better at maths and you do less work" (Stevie, Inspire)

"Before, I'd spend a couple of lessons just working out where they're at in the classroom and it's a waste of time (Sam, MNP)

Additionally, the structure of the textbook provides several benefits: it seems to have made assessment easier for teachers, it permits the use of representations (see Section 6.1.2), and it is supportive, yet allows for autonomy, in how NQTs plan lessons. In having a whole-school approach to mastery and the use of a textbook, it seems inevitable that consistency in the children's experiences is supported, in addition to providing staff with a shared purpose, potentially leading to ongoing conversations about mathematics.

6.4.2 Constraints

While we noted in Sections 6.2.1 and 6.4.1 that the NQTs appreciated the 'safety net' provided by the structure of the textbook, it should be highlighted that not all of the textbooks adopted by the schools in this study offered the same level of clarity in their structure to users:

"Sometimes they can be a little bit obscure, if that's the right word, in how they explain things. I don't always find it incredibly clear how it's explained" (Phil, Inspire)

"they're not necessarily a progression in terms of difficulty and are not always laid out consistently or they don't go easy to hard, for example, so you might have some children who are stuck on the first page, but that's not necessarily easier than the pages that follow" (Phil, Inspire)

"I think White Rose skips over that because they think we've already done it in past years" (Daryl, WR)

"a negative side to White Rose, is that some of the teaching comes after the SATs. So that's not possible and we've got to rejig it in order to get the coverage in before SATs" (Bobbie, WR)

Additionally, NQTs described a mismatch between the overarching objectives of the textbook and their own as a constraint. For example, Phil, who previously identified seeking to develop 'different ways of thinking' (see 6.1.1), perceives a lack of opportunity to do so in the published materials he is using:

"the ways of looking at a question in different ways, I don't know if that's always fully supported by the textbook" (Phil, Inspire)

In Section 6.1.2, the issue of accommodating the lowest attainers was flagged. At the opposite end of the attainment spectrum, NQTs also described needing to adapt the materials in order to best meet the needs of higher-attaining pupils.

> "Sometimes there's not enough, so we do have to come up with more challenges or more questions for the children to do" (Taylor, MNP)
>
> "but they're not necessarily a progression in terms of difficulty and are not always laid out consistently or they don't go easy to hard, for example" (Phil, Inspire)

However, this may reflect a lack of appreciation of some of the decisions made about the sequencing or presentation of textbook materials, and subsequent opportunities for learning.

> "when it gets to the guided practice there won't necessarily be any commentary for this bit, but this is the part where often there's the connections to be made and that evidence of greater, deeper thinking is really evident in this part of it. But there's no commentary for this part… And that's the bit where I always worry that if teachers don't look carefully enough they're going to miss opportunities for their greater depth children" (Jamie, MNP)
>
> "The danger is also if people misunderstand the pace that's required, so they go too fast and miss bits out or they go too slow and don't do the coverage" (Stevie, Inspire)

Within the course of the interviews, other potential constraints – including the prohibitive cost of the textbooks and the physical problems very young children have in handling the heavy books – were also raised and warrant further examination beyond the scope of this study.

7 Conclusions and Recommendations

This research has illuminated some of the opportunities and challenges encountered by NQTs as they implement a mastery approach using a textbook in their first teaching post.

7.1 Conclusions in relation to the research questions

This section sets out conclusions arising from each of the three research questions and leads to the recommendations in section 7.2.

7.1.1 Research question 1: What is the nature of newly qualified primary teachers' understanding of a mastery approach?

Findings have established that for the NQTs taking part in this research, conceptualisations of mastery are interconnected and reflect understanding of mastery as a goal and mastery as an approach to teaching mathematics. While some of the key components of mastery, namely depth, flexibility in problem solving, collaboration and talk, the use of representations, conceptual simplification and same-day intervention are embedded in their understanding, others such as variation were less clearly evidenced in their responses.

7.1.2 Research question 2: How do Newly Qualified Teachers make use of textbooks to translate theory into practice?

Data reflects strong support derived from the structure of the textbook both in relation to learning over time and learning within a lesson. While the textbook provided structure, it did not diminish teacher autonomy; NQTs were empowered and expected to make adjustments to meet the needs of their pupils. Textbook structure enabled NQTs to make pedagogical decisions within a safe framework which provided confidence that learning was at or aiming at an appropriate level.

7.1.3 Research question 3: How are Newly Qualified Teachers supported to understand the role of textbooks in the transfer of theory to practice?

NQTs are able to draw productively on their understanding of key learning theorists in talking about their mathematics teaching practices in some fundamental aspects of 'Teaching for Mastery'. Experiences as part of ITT have provided understanding that is supportive as they navigate their use of the textbook and influences their decisions and approach.

Interviews with NQTs and MSLs reflect comprehensive and wide-ranging support for NQTs as they learn to use and apply the textbook approach. As well as receiving bespoke support as NQTs, there is a strong sense of learning alongside colleagues who are also developing new practices; arguably this has benefitted the induction of NQTs into school teams; they are not the only ones learning and managing uncertainty.

Arising from these findings we conclude that:

- Within six months of taking up their first posts, NQTs are already demonstrating understanding of key components of a mastery teaching approach. Moreover connections established by NQTs between these components of mastery and their understanding of learning theory provide confidence in decision making. Unsurprisingly there is more for these NQTs to learn and in this regard, ITT, schools and textbook publishers all have a role to play in making explicit the connections between learning theory, mastery and the structure and organisation of textbooks.

- The use of textbooks provides support through structure and progression without reducing teacher autonomy. We find a reassuring confidence in decision making on the part of the NQTs interviewed together with an understanding of their responsibility, (not the textbook's) for pupil learning and progress.

- Support for induction of NQTs into the use of textbooks needs to be comprehensive, ongoing, explicitly linked to theoretical underpinnings and connections, and to increasingly address the more subtle features of textbook structure and organisation. While publisher-led intensive training (over several consecutive days) may not be appropriate in their first year, the benefits that those attending such training have derived from it suggest that it would be a worthwhile investment in supporting new teachers in their second or third year of practice.

- Through whole staff ongoing CPD, and the generation of shared learning, development and problem-solving, the implementation of textbooks can be supportive of the development of teacher subject knowledge.

7.2 Recommendations

The following recommendations are made for schools, teacher trainers and publishers respectively, arising from our conclusions:

7.2.1 Recommendations for schools

- Ensure that all support for NQTs makes explicit connections between learning theory, key components of mastery and the textbook approach, to 'Teaching for Mastery'
- Ongoing support for NQTs should begin to address some of the more challenging elements of a mastery approach (variation, careful selection of examples, appreciation of structure, relationship between small steps and the larger whole) to enable NQTs not just to understand how to use the textbook but how to understand and capitalise on the more subtle aspects of design.
- Senior school leaders, in line with the recommendation of Hall, Lindorff & Sammons (2016), should take an active part in leading on, and engaging with, textbook implementation
- Establish a programme of attendance of key staff at intensive publisher led training supplemented by regular opportunities for all staff to engage in reflective and analytical discussion of aspects of the textbook's approach to 'Teaching for Mastery'

7.2.2 Recommendations for teacher trainers

- Continue to embed learning theory into provision, including both seminal and recent research
- Support students in understanding the connections between learning theory, including variation theory, and components of mastery teaching so that trainees understand mastery practices as established in theory rather than as a 'new idea'
- Lay the foundations for NQTs to:
    - understand how representations enable access to mathematical concepts
    - understand how learning can be facilitated by enabling children to make connections between and within modes of representation
    - draw on subject knowledge in critically selecting representations and choice of examples, identifying what is being made visible

7.2.3 Recommendations for publishers

- Encourage schools to enrol NQTs+1 on intensive publisher-led training. We view the NQT+1 year as a more productive positioning of intensive training for new teachers than either the NQT year, or the years beyond NQT+1. While within school support and training is undeniably required in the NQT year, new teachers will be able to maximise the impact of intensive publisher led training when experience of class teaching, of planning over individual lessons and sequences of lessons is already embedded, and when the rudiments of textbook use are already understood. Publisher-led training can then support the NQT+1 to connect their ITT based understanding of theory with the way that the text book develops

mastery. They will also have classroom experience to draw on as a basis for reflection and evaluation.

- Develop bespoke additional top-up CPD addressing more subtle elements of mastery such as variation theory. We noted a limited understanding amongst NQTs and MSLs in relation to variation theory in particular. Our intention in expressing this is not to criticise these teachers; on the contrary, our data suggests rapid development in their understanding of mastery. However, the full impact of the textbook on pupil learning requires understanding of the way in which variation is addressed. This was alluded to by one MSL (Jamie, MNP!, section 6.2.3) who commented that it was important that all teachers understood why all questions in a sequence were needed; our interviews with NQTs and MSLs lead us to consider that specific training focusing on variation and how the text book embeds this in its structure, would be of benefit to schools.

- Provide guidance to schools in relation to the sequencing and content of ongoing whole school CPD to support schools to fully adopt the pedagogical intentions of the textbook. This recommendation arises from our awareness during interviews that schools are grappling with a variety of elements of mastery at different times in the embedding of their textbook schemes. Whilst the MSLs that we interviewed were frequently devising their own staff development to address these features, a set of training materials that could either be bought into or downloaded would assist the MSLs in this task and ensure that key messages and theoretical underpinning were evident in this training.

- Investigate the extent to which the use of mastery textbooks supports teachers to manage the needs of children working significantly below or above age-related expectations. This was not a specific avenue of enquiry in the interviews, however we noted different approaches to addressing the needs of these pupil groups, particularly those who struggled with age related content. Arising from this, a productive avenue for future enquiry might be to focus specifically on the way that textbook progression and materials are adjusted, or how additional resource is directed, to meet pupil need and the impact of this on learning and progress. Such understanding would be valuable in both promoting the textbook to new, and supporting existing, schools in ensuring that all pupils are supported to achieve mastery and to deepen their understanding of mathematics concepts.

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Appendix A: Ethical approval for project

University of Brighton

School of Education Research Ethics Panel

School of Education
Checkland Building 326
Falmer
BN1 9PH

01/04/2019

Ref: 2018-0478-Marks The use of textbooks to support a mastery approach in the primary school

Dear Rachel

The School of Education Research Ethics Panel are happy to offer a favourable ethical opinion for this study.

A favourable ethical opinion is subject to the following conditions:

Favourable ethical opinion is given on the basis of the information provided in your application, including a project end date of 29/03/2019. Please note that the School of Education Research Ethics Panel must be informed of any changes to the research process after a favourable ethical opinion has been given. If you need to make changes to your proposal, including requesting an extension, please complete and submit a change request form in order that the School of Education Research Ethics Panel can determine whether the changes will necessitate any further ethical review.

We wish you all the best with your research and hope that your research study is successful.

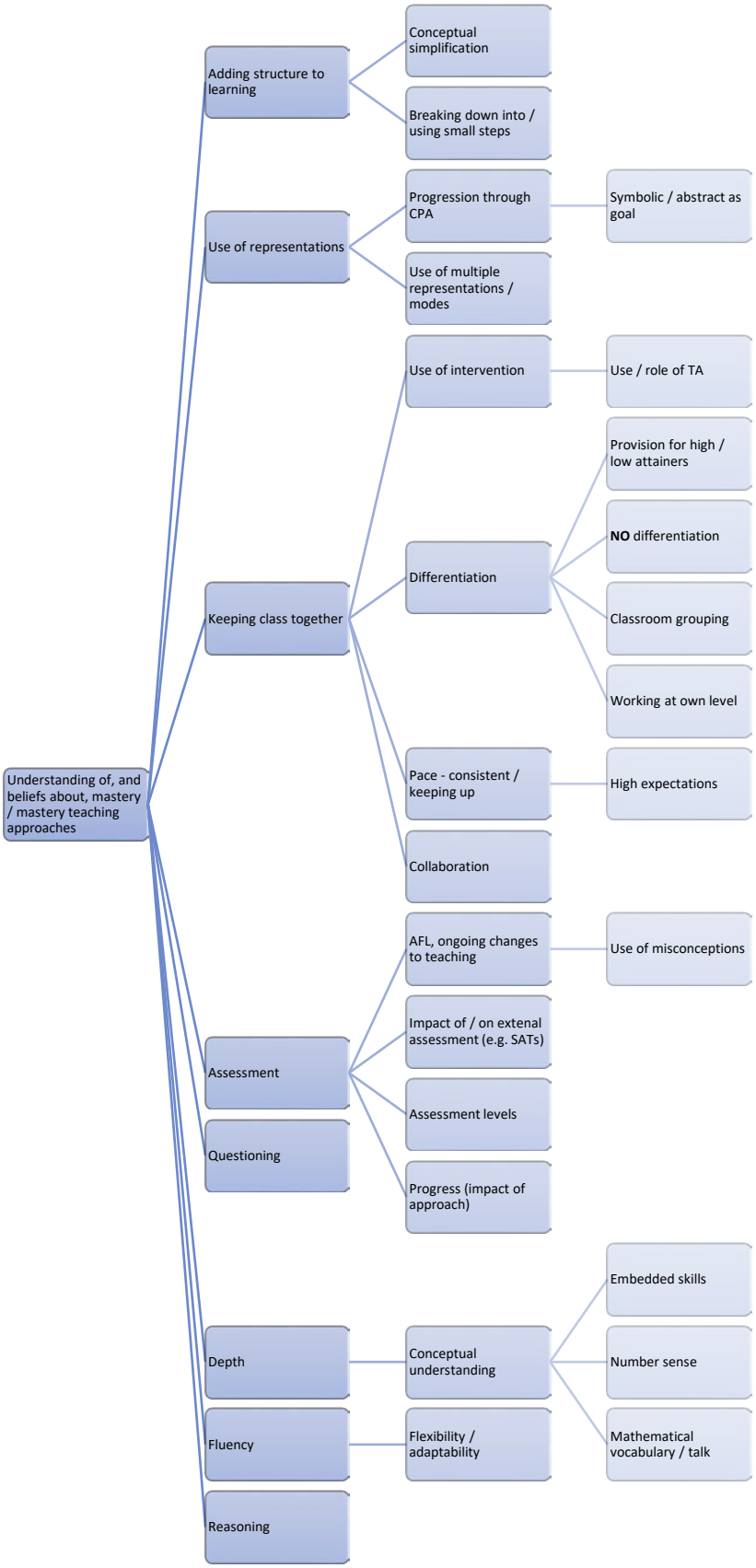
Best wishes

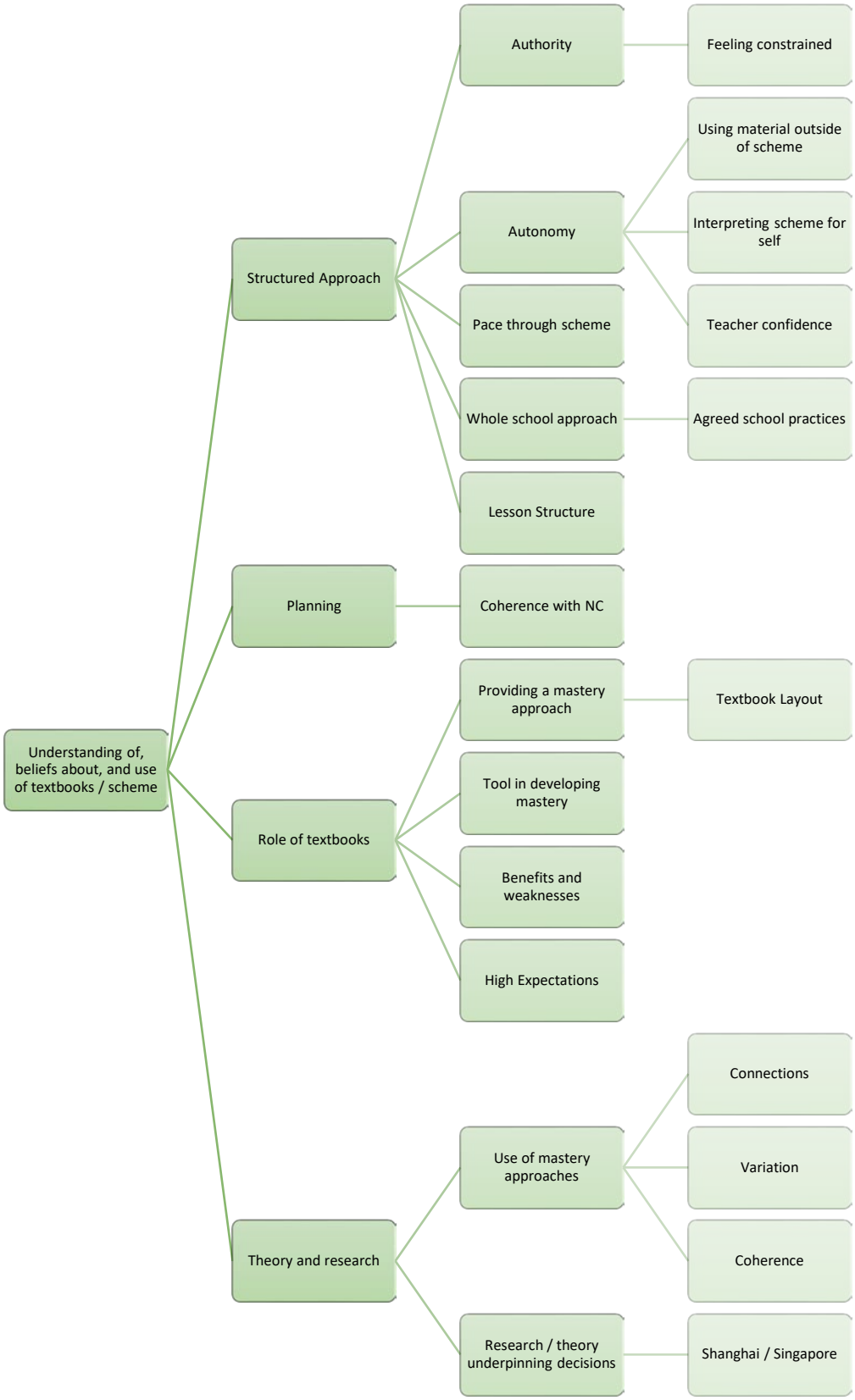
Dr Brian Marsh

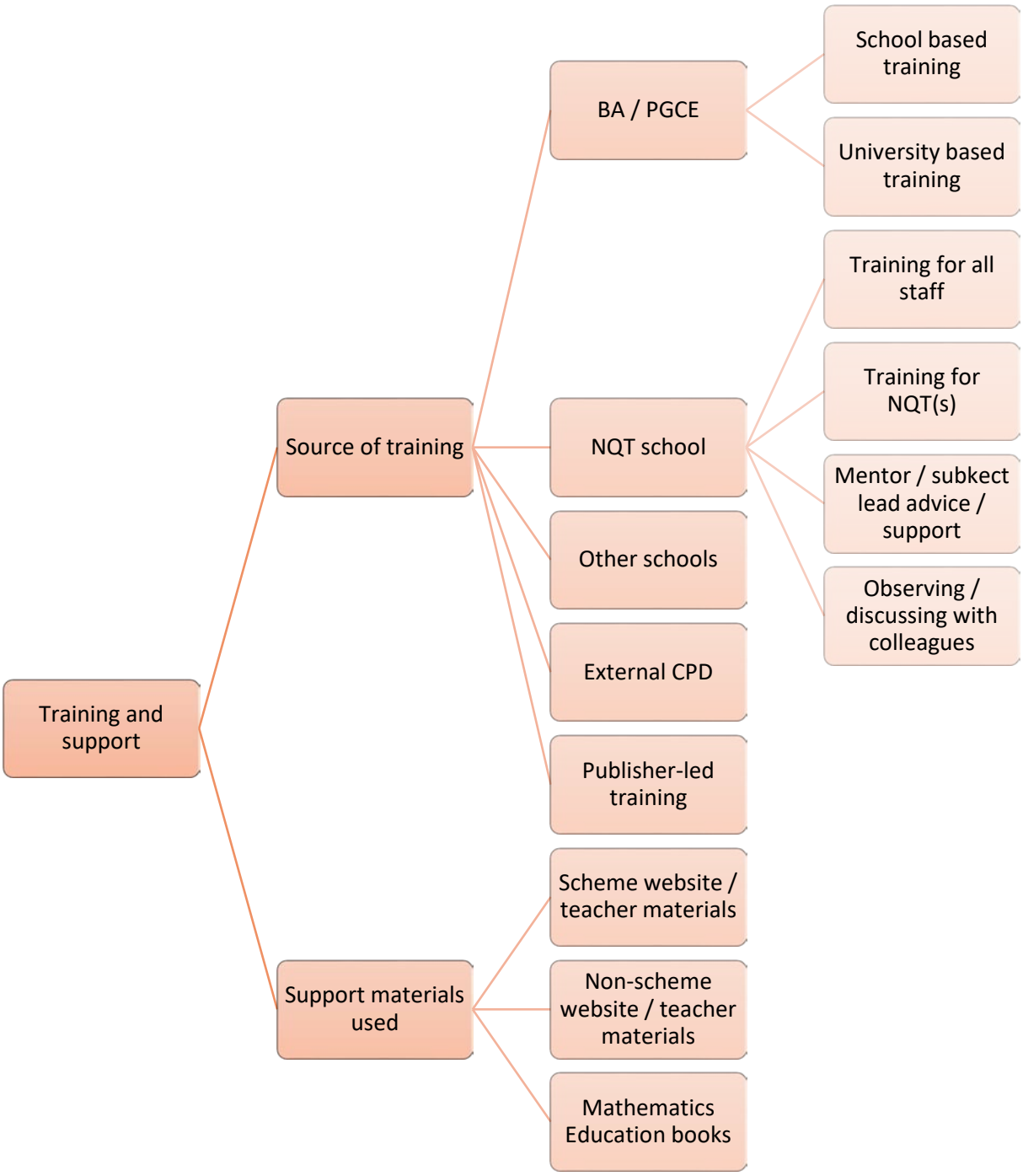
Chair, School of Education Research Ethics Panel

Appendix B: Tree Map of NQT interview utterances

Appendix C: Coding schedules




Understanding of, beliefs about, and use of textbooks / scheme
Structured Approach
Authority
Feeling constrained
Autonomy
Using material outside of scheme
Interpreting scheme for self
Teacher confidence
Pace through scheme
Whole school approach
Agreed school practices
Lesson Structure
Planning
Coherence with NC
Role of textbooks
Providing a mastery approach
Textbook Layout
Tool in developing mastery
Benefits and weaknesses
High Expectations
Theory and research
Use of mastery approaches
Connections
Variation
Coherence
Research / theory underpinning decisions
Shanghai / Singapore


Training and support
Source of training
BA / PGCE
School based training
University based training
NQT school
Training for all staff
Training for NQT(s)
Mentor / subkect lead advice / support
Observing / discussing with colleagues
Other schools
External CPD
Publisher-led training
Support materials used
Scheme website / teacher materials
Non-scheme website / teacher materials
Mathematics Education books